The effects of thinking in silence on creativity and innovation

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THE EFFECTS OF THINKING IN SILENCE ON CREATIVITY AND INNOVATION

ARNOUD J. DE VET

Dedicated to Dr. Arnoud C. de Vet (1904–2001)
and Emilie C. de Vet (2002–), who led me to pursue a Ph.D.

THE EFFECTS OF THINKING IN SILENCE ON CREATIVITY AND INNOVATION

PROEFSCHRIFT

ter verkrijging van de graad van doctor aan de Universiteit van Tilburg, op gezag van de rector magnificus, prof. dr. F.A. van der Duyn Schouten, in het openbaar te verdedigen ten overstaan van een door het college voor promoties aangewezen commissie in de aula van de Universiteit op vrijdag 16 november 2007 om 16.15 uur door

ARNOUD JOHAN DE VET
geboren op 18 februari 1972, te Schiedam

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PREFACE

'Dream as if you'll live forever. Live as if you'll die today.' – Unknown

One of the things that you learn whilst pursuing a Ph.D. is writing. Harry Barkema taught me how to position, how to frame, and how to clearly explicate causal mechanisms. Furthermore, I learned a crucial lesson from Professor Strunk (2000) who used to impress upon his students to avoid writing too lengthy texts, barking to them from his lecturer stand: 'Omit needless words!' followed by a deafening silence. I hope that this dissertation is proof that I have learned something from these men.

Now, let me answer three essential questions: Why did I pursue a Ph.D.? What was the process like? What did I learn?

Why did I pursue a Ph.D.?

On April 3rd, 1936, Arnoud C. de Vet, my grandfather and intellectual role model, defended his dissertation 'On the diagnostics of the meningioma cerebri'. He went on to become one of the most celebrated neurosurgeons in the Netherlands, as a physician and as a researcher (he published 62 academic papers). In the 1980s and 1990s, 'Bonpapa' tried to impress upon me, the young man that I was, the importance of pursuing a Ph.D. To his regret, he failed. I was certain that a Ph.D. would have no value for my career as a businessman and management consultant, and hence surely I did not want to waste precious time on writing a dissertation. He did however plant the seed in my mind.

A fertile environment for this seed to sprout was provided by my daughter Emilie. Her adventurous birth made me reconsider the fundamental decisions in life. In the spirit of the quote at the start of this preface, I left McKinsey, in search of intellectual depth and a balanced lifestyle. I found both in the academic world. Let me thank Laurens Sloot and Professor Harry Commandeur and also Professor Peter Leeflang for helping me navigate this terra incognita. The route led to Professor Harry Barkema at Tilburg University, who removed multiple obstacles including a budget freeze to pave the way for my recruitment.

What was the process like?

It was hard work. The two-year course-load was challenging and therefore enjoyable. The theoretical courses stimulated me to strengthen my logical thinking (e.g. regarding causality) and the empirical courses provided a level of methodological rigor and statistical tools that are many steps more advanced than anything I had previously used as a management consultant. For my formal training, I especially thank Professor Jean-Francois Hennart and Professor Xavier Martin (inspiring examples of razor-blade sharp thinking), and Professor Tammo Bijmolt (a wonderful guide in the world of advanced multivariate statistics).

One of the most satisfying aspects of pursuing a Ph.D. is the opportunity to teach the next generation. For two years, I helped bachelor students learn about organizational behavior, i.e. about what individuals and groups can do to affect organizational performance. The course developed together with Mario Schijven focused on rigorously tested but surprising, counterintuitive, insights from the academic management literature that are relatively easy to put into practice. Investing time in developing a surprising course is a

worthwhile and highly satisfying pursuit, even if only for the enthusiastic reactions by the students.

What did I learn?

So, were these four academic years fully worth it? The answer is a resounding yes: I have learnt tremendously. I have been able to develop a much deeper understanding of strategic and organizational issues, particularly in the area of innovation and groups, and especially where based on social and cognitive psychology. In addition, I have acquired theoretical concepts and empirical tools that allow sharper thought processes. This is clearly helpful in my current occupation as an independent management consultant. Many consultants do not properly understand and use such concepts and tools, such as e.g. moderation and mediation, hierarchical regression modeling, endogeneity, structural equation modeling, and advanced statistical significance testing. Working as an independent consultant whilst finalizing this dissertation, I have already been able to save clients a considerable amount of money using the tools I acquired as a Ph.D. candidate.

Let me thank my wife Brigitte for being a great intellectual and emotional support during these years. My papers have improved because of her, and so has my life. She knows that I love her. A thank you to my parents Trees and Ben, for having stimulated my development from 1972 onwards, for always supporting my choices in life and for spending many weeks with the kids, so that I could be in Tilburg to do research and to teach. A big kiss and hug to the three small wonders in my life: Emilie for allowing me to be the most important man in her life (for the moment) and for getting her father a Ph.D., Alexander for being so adventurous and open to new experiences, and Marie for having such a positive and peaceful outlook on life and for always, always smiling.

TABLE OF CONTENTS

CHAPTER 1
INTRODUCTION

It is generally acknowledged that in order to sustain and enhance performance, firms need innovation. Innovation is here defined as the 'intentional introduction and application within a job, work team or organization of ideas, processes, products or procedures which are new to that job, work team or organization and which are designed to benefit the job, the work team or the organization' (West & Farr, 1990). Innovation allows companies to grow, to win in the competitive race, and to make high profits, and it allows societies composed of innovating companies to enjoy high employment levels, high wages, and high standards of living.

There is a substantial amount of research on innovation: in the year 2006 alone there were 1777 papers with innovation as topic listed in the Web of Science Social Sciences Citation Index. Most of this research attempts to identify the factors that lead to innovation. First, of all there is a lot of research at the firm level of analysis, e.g. regarding patterns in R&D expenditures (Cohen & Levinthal, 1990; Penner-Hahn & Shaver, 2005), threats of innovation to incumbents (Henderson & Clark, 1990; Hill & Rothaermel, 2003), exploration vs. exploitation (March, 1991; McGrath, 2001; Rothaermel & Deeds, 2004), market orientation (Atuahene-Gima, 2005; Christensen & Bower, 1996; Faems, Van Looy, & Debackere, 2005; Narver, 2004), and alliances of a firm (Ahuja, 2000; Oxley & Sampson, 2004).

However, not only the firm level of analysis can shed light on factors that affect firm innovation. Innovation by firms is a product of individuals and teams working together. Innovation is essentially a product of useful new ideas. Such ideas are first generated by an individual or a team and are then

adopted and institutionalized by the firm (Crossan, Lane, & White, 1999). Innovation performance by a firm is hence clearly dependent on generation of useful novel ideas (creativity) and the selection of useful novel ideas (decision-making) by individuals and teams. This dissertation focuses on exactly that: the generation and selection of useful novel ideas by individuals and teams.

In terms of the factors that affect creativity and decision-making in the context of innovation, I focus on thinking in silence, as opposed to thinking aloud at the individual level of analysis, and as opposed to group debate at the group level of analysis.

There is a number of streams of literature on the effects of thinking in silence on individual cognitive performance (see chapters 2, 3, and 4 for reviews). Some streams suggest these effects are positive (e.g. verbal overshadowing, production blocking), some suggest these are negative (e.g. verbal activation). The literature on the effects of thinking in silence on innovation is filled with important gaps which I define precisely and address in chapters 2- 4.

Our research objective in chapter 2 is to study, at the individual level of analysis, under what conditions thinking in silence actually hinders creativity, and under what conditions it does not. We combine social psychological and cognitive psychological lenses to study the effect of an interaction of two self-monitoring variables on creativity. We test our theory in a university laboratory setting with two large randomized experiments, using standard procedures and measures. This paper is co-authored with Prof. Dr. Carsten K.W. de Dreu and in press in the European Journal of Social Psychology (A 'high impact journal' according to the Social Science Citation Index Impact Score 1.6 (2005), which is similar to

the scores of e.g. Journal of Product Innovation Management and Journal of Management).

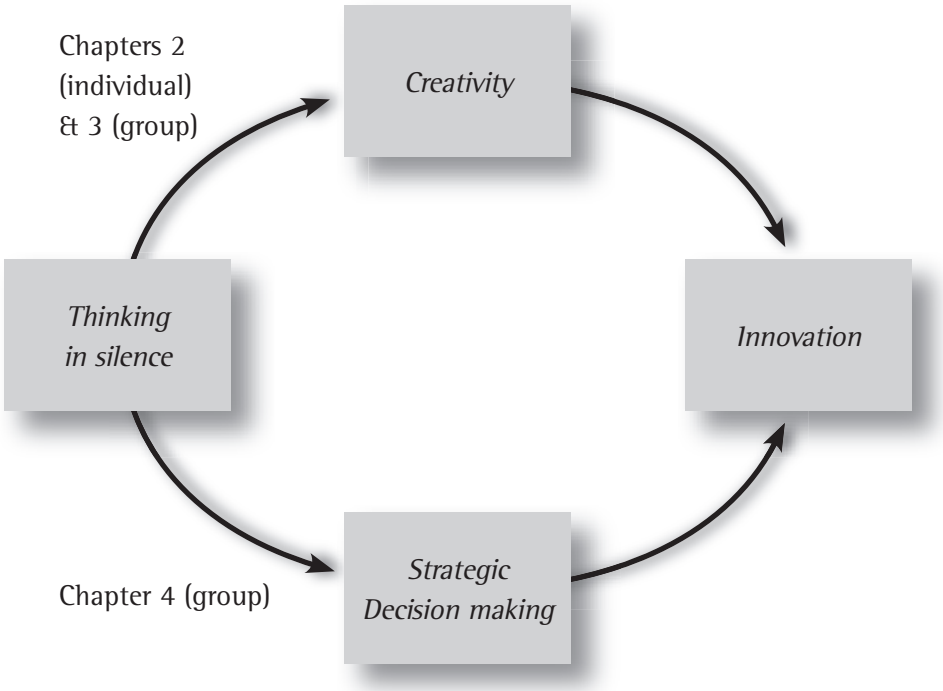
In chapter 3, I take the study of the effect of thinking in silence on creativity to the group level of analysis, and focus on the effect thinking in silence versus group debate on creativity (which is an important input for innovation). Scholars writing in the management literature typically assume that group debate can have positive effects on innovation, and they study under what circumstances the effect of group debate is most positive. For example, Simons, Pelled and Smith (1999) find that debate characterized by defending viewpoints and challenging those of others allows teams to capture the benefits of diversity. Postmes, Spears and Cihangir (2001) find that critical debate, rather than debate focused on consensus, positively affects information sharing, a key factor influencing group performance. Jehn and Mannix (2001) find that debate characterized by *moderate* task conflict at the midpoint of group interaction positively influences group performance. Barkema and Chyrkov claim that constructive debate mediates the effect of top management team diversity on strategic innovation, such as technological and bureaucratic innovation, entry into new product markets, and so on (Barkema & Chvyrkov, 2007). The underlying assumption in the cited and other management literature is that group debate is more effective for innovation than individuals thinking alone. This dissertation challenges that belief: the research objective of chapter 3 is to study in which conditions *suspending* group debate (temporarily) can be productive for creativity. I use a social (cognitive) psychology lens, combining it with personality psychology, to theorize that when at least one group member has relatively low extraversion, suspending group debate temporarily (in the form of an intermezzo for thinking alone), may increase group creativity. The randomized experiment (using relatively standard procedures and standard

measures) with pre-existing student teams working on developing solutions for a real problem on campus supported my predictions. This paper benefited from the frequent discussions with my supervisor, Prof. Dr. Harry Barkema.

Chapters 2 and 3 focus on the effect of thinking in silence on idea generation (creativity) at respectively the individual and group level of analysis. In chapter 4, I shift the focus from the generation of ideas to the selection of ideas, at the group level of analysis. The research objective in this chapter is to study the effect of group debate on the strategic decision to adopt an incremental innovation or rather a more radical innovation for market implementation. Such decisions are usually strategic in nature for a firm, given that strategic decisions are those that are "important, in terms of the actions taken, the resources committed, or the precedents set" (Mintzberg, Raisinghani, & Theoret, 1976). Although group debate and strategic decision-making have both been extensively studied in the literature, there has been a lack of research on the effect of group debate on strategic decision-making in the context of innovation, as far as my colleagues in the management and psychological disciplines and I can tell. In chapter 4, I combine disconnected streams of cognitive psychology literature on the impact of verbalization with social psychology literature on self-monitoring, and theorize that depending on specific team characteristics group debate may increase the likelihood of adopting a radical innovation or decrease it. This theory was supported by a randomized experiment (using relatively standard procedures and standard measures) with pre-existing student teams. Both theory and experiment were supported by frequent discussions with my supervisor, Prof. Dr. Harry G. Barkema.

The focus of this dissertation and the focus of each substantive chapter is summarized in Figure 1.

Figure 1.1
Overview dissertation



CHAPTER 2
THE INFLUENCE OF ARTICULATION, SELF-MONITORING ABILITY, AND SENSITIVITY TO OTHERS ON CREATIVITY

By Arnoud J. De Vet and Carsten K.W. De Dreu
In Press in European Journal of Social Psychology.

Abstract

Although it is often recommended to think aloud to solve problems and to become more creative, cognitive and social psychological research suggests thinking aloud may actually produce less creative ideas than thinking in silence. The results of two experiments indeed showed that thinking aloud hinders creativity – although people produced the same amount of new uses for an object, these were judged to be less original in the thinking aloud condition. Experiment 2 further showed that this effect was particularly pronounced for individuals with high sensitivity to what other's think of them and low ability to adapt to these expectations. From this we conclude that the felt presence of an actual or implied audience when thinking aloud reduces creative idea generation especially among those having difficulty adapting to others. Implications for creativity research and for the promotion of creativity in applied settings, such as in organizational teams, are discussed.

2.1. INTRODUCTION

In many social settings creativity is valued and sought after. Creative thought helps people to learn and develop, to solve problems, and to settle their conflicts. Social psychologists indeed have a longstanding interest in the interplay between creative thought and group processes. Numerous studies on brainstorming compared groups with individuals brainstorming alone (e.g. Diehl & Stroebe, 1987; Nijstad & Paulus, 2003a), or the impact of different viewpoints on creative group processes and team innovation (e.g. De Dreu & West, 2001; Nemeth, Personnaz, Personnaz, & Goncalo, 2004). Most of this work has considered creative idea generation when members of the group express their thought aloud, so that others can hear them and perhaps benefit. Thinking aloud as an elicitation method resonates with the intuitive notion that when talking about one's problem often the solution presents itself. It also resonates with common practice in many applied settings, such as organizational teams, where it is recommended that articulating tacit ideas leads to social sharing, which in turn is supposed to foster creativity and work place innovation (e.g. Nonaka & Takeuchi, 1995). It finally resonates with some work in cognitive psychology, which we review below. However, there is good reason to believe that thinking aloud hinders rather than helps creative thought, and we review this work as well. We present two experiments in which we tested whether and when thinking aloud helps or hinders creative idea generation.

2.1.1. Does thinking aloud help or hinder creative ideation?

The idea that thinking aloud promotes ideation may be inferred from memory theories. Research has shown that thinking aloud enhances the capacity of working memory (Baddeley, 1999). For instance, participants repeating

out loud a phone number remember longer numbers than those repeating it silently. Likewise, Chi and colleagues (Chi, de Leeuw, Chiu, & LaVancher, 1994) found that participants who thought aloud about what they had previously read remembered more of it than participants who silently thought about the same passage. In other words, thinking aloud may enhance memory and thus the knowledge available.

Although enhanced memory is certainly no guarantee for more creative performance (Amabile, 1996; Simonton, 2000), the literature on language and thought suggests that articulation can have a positive effect on creativity (e.g. De Saussure, 1915/1983; Luria, 1982; O'Grady, Archibald, Aronoff, & Rees-Miller, 2001; Slobin, 2000; Steinberg, Nagata, & Aline, 2001; Vygotsky, 1934/1986). People use a mental lexicon when they produce speech and using a word activates other words and their meanings. This mental lexicon contains word forms, their related sounds, and concepts that convey their meaning (Gazzaniga, Ivry, & Mangun, 2002), and through automatic spreading activation in the mental lexicon other words and their meanings are activated. Because individuals use more words when they think aloud than when they think in silence (Duncan & Cheyne, 1999; Holodynski, 2004), it may well be that more constructs are activated when thinking aloud than when thinking in silence (cf. Vygotsky, 1934/1986). As a result, thinking aloud may stimulate creativity.

Evidence for the idea that thinking aloud may enhance creative performance is provided by Wetzstein and Hacker (2004). In their experiment, the impact of question-based reflective verbalization on the quality of design solutions was investigated. After participants had designed an object, they were asked to verbally describe their design (or not, in a control condition), and then

continued their design. Results showed that the design quality improved substantially, that the experimental group invented new principles and added novel functions to their design.

Because thinking aloud may activate more constructs than thinking in silence, and because thinking aloud enhances working memory capacity, thinking aloud may increase creative idea generation. However, there is good reason to believe thinking aloud may actually hinder creative thought. First, speech production – looking up word forms in the mental lexicon and structuring them into a sentence, looking up sounds in the mental lexicon, and actually articulating – requires cognitive processing (e.g., Levelt, 1989). Thinking aloud may thus lower the processing capacity available for creative performance.

Several studies speak to the possibility that thinking aloud undermines creativity. A study by Schooler, Ohlsson and Brooks (1993) showed that "verbalization can result in the disruption of non-reportable processes that are critical to achieving insight solutions" (p. 166). These authors show that verbalization of nonverbal tasks can interfere with successful performance. They report four experiments to determine the effect of various forms of articulation (e.g. retrospective verbalization of the problem solving strategies after an interruption, concurrent verbalization during problem solving) on solving insight problems and non-insight problems. Results showed negative effects of verbalization on insight problems, and no effect on non-insight problems.

Work by Kim (2002) qualifies this notion. She found that talking aloud has a negative influence on solving reasoning problems for participants from East Asia. For participants with a European background, however, talking aloud

had no significant effect on reasoning performance. The explanation offered relies on the idea that people from East Asia tend to think in a nonverbal way, and that for them "the thinking-aloud task should impair performance, because the person would need to work on an extra task of converting his or her thoughts into words on top of the main problem-solving task" (p. 835). Participants with a European background, however, think more verbally and for them "the task of thinking aloud should not affect the performance on problem solving very much, because his or her thoughts are ready to be vocalized as words" (p. 835).

For two reasons, we cannot be certain that thinking aloud reduces creative performance. First, because the Schooler et al. (1993) study was conducted with participants with a European background, the results by Kim (2002) cast some doubt on the generality of the notion that thinking aloud reduces problem solving and reasoning performance. Second, the tasks used in the work by Schooler et al. (1993) and Kim (2002) are only indirectly related to creativity. Creative performance can be decomposed into fluency (generating many ideas), flexibility (using different cognitive categories to sample ideas from), and originality (generating new and unusual ideas and perspectives). Whereas solving insight problems may require cognitive flexibility and divergent thinking, it not necessarily requires fluency and originality. Prior work on articulation thus hints at the possibility that thinking-aloud undermines creative performance, but cannot answer the question whether articulation indeed reduces cognitive fluency and/or originality. In fact, work by Fleck and Weisberg (2004) suggests that effects of articulation do not transfer to creative performance. These authors found no effects of the Schooler et al verbalization procedures on creative problem solving (i.e., Duncker's candle problem).

Taken together, from the above works it remains unclear whether the putatively negative effects of thinking aloud transfer comfortably to creative performance. However, and albeit for quite different reasons, social psychological theory also suggests that thinking aloud hinders creativity. Articulation brings an individual's thoughts out in the open for all to scrutinize, which brings about a feeling of being observed. Feeling observed promotes self-evaluation (James & Olson, 2000; Plant & Ryan, 1985) and self-evaluation has a well-documented negative effect on creativity (Cottrell, Wack, Sekerak, & Rittle, 1968; Plant et al., 1985; Silvia & Phillips, 2004; Szymanski & Harkins, 1992). For example, a study on brainstorming by Camacho and Paulus (1995) showed that individuals high in social anxiousness generated less original ideas when brainstorming in groups rather than alone. This resonates with work on electronic brainstorming showing that individuals generate fewer original ideas when they can be identified, compared to when they cannot (Connolly, Jessup, & Valacich, 1990). It also resonates with the classical finding that brainstorming groups, in which members express ideas verbally, are less fluent and less original than individuals brainstorming alone (Bond & Van Leeuwen, 1991; Diehl & Stroebe, 1991; McGrath, 1984; Mullen, Johnson, & Salas, 1991)

Productivity loss in brainstorming groups has been attributed to production blocking – group members need to wait for others to finish expressing their ideas, and this undermines the formation of new ideas (Diehl et al., 1987; Nijstad, Stroebe, & Lodewijkx, 2003b; Stroebe & Diehl, 1994). Interestingly, however, in some studies group members expressed their ideas verbally while in other studies ideas were written down. Mullen et al. (1991) reported meta-analytic evidence that productivity loss was greater when ideas were expressed verbally, supporting the idea that thinking aloud undermines

creative performance, at the least when people are working in groups and can observe each other.

2.1.2. Overview of the present study

The literature reviewed above suggests two contrasting predictions: (1) thinking aloud leads to more creative ideas than thinking in silence, versus (2) thinking aloud leads to less creative ideas than thinking in silence. For both predictions some indirect evidence was reviewed. The first prediction is theoretically grounded in cognitive and language psychology and is consistent with work on object design (Wetzstein & Hacker, 2004). The alternative prediction is consistent with some verbal overshadowing work on insight problems (Schooler et al., 1993; but see Kim, 2002), and work on group brainstorming (e.g., Mullen et al., 1991). , Although the evidence for this second prediction is solid, we stress that verbal overshadowing does not seem to transfer comfortably from insight tasks to creative performance (Fleck & Weisberg, 2004), and that in group brainstorming there necessarily is a social context that may elicit social anxiety (Camacho & Paulus, 1995). To really settle the debate on the effects of thinking aloud, we thus need new data. In Experiment 1 we compared the number of original uses for a tin can mentioned by participants in a thinking aloud and a thinking in silence condition. This experiment thus simply discriminates between the two perspectives outlined above. Experiment 2, employing a similar methodology, was designed to further explore the boundary conditions of the results of Experiment 1.

In both experiments we employed the unusual-uses test, which is commonly used in creativity research (e.g., Csikszentmihalyi, 1975; Eisenberger & Armeli, 1997; Guilford, 1967; Silvia et al., 2004; Szymanski et al., 1992;

Torrance, 1962). The task allows one to assess creativity on a specific task and has been demonstrated to be sensitive to experimental manipulation (e.g., Hocevar & Bachelor, 1989). To manipulate articulation, we used a typical think-aloud procedure (Ericsson & Simon, 1993; Kim, 2002). Participants in the think-aloud condition were asked to give a concurrent verbal report, i.e. to verbalize cognitive processes directly rather than after the fact. Those in the thinking-in-silence condition were, in contrast, explicitly instructed to remain silent while thinking about new uses for a tin can.

2.2. EXPERIMENT 1

2.2.1. Method

Participants and experimental design. Forty five senior economics students at the Erasmus University Rotterdam participated for course credit. Participants were randomly allocated to a thinking-aloud or a thinking-in-silence condition. Dependent measures were the number of ideas generated, and their originality.

Procedure. The study took place in large lecture halls with over 500 seats. As students entered the lecture hall they were randomly assigned to a seat. Because of the size of the lecture halls participants were always seated far apart. Each seat contained a set of earplugs and a headset for participants to use. The experimenter introduced the study by telling the students they were about to participate in a study about thinking strategies. He then asked participants to put in the earplugs and to put on the headsets so that thinking aloud would not distract other participants. In the thinking-in-silence condition the same procedure was followed.

The experimenter handed out booklets and asked participants to start working at his sign (to ensure that all participants would spend the same amount of time on the task). The booklets instructed participants to think of unusual uses for a tin can, one of the Torrance Tests for Creative Thinking (Torrance, 1962). Half of the participants were instructed to do so silently; the others were instructed to think aloud. After 5 minutes, participants were instructed to stop and to hand in their booklet.

Four students from the same population who had not participated in the experiment each evaluated the responses of all participants. Each judge used a different, randomized order, and was asked to count (1) the number of ideas and (2) the number of original ideas. Following Torrance (1962) and other studies using this task (e.g., Eisenberger & Armeli, 1997; Guilford, 1967; Silvia & Phillips, 2004; Szymanski & Harkins, 1992), ideas were considered original if they could not be placed in one of the following categories: using the tin can (a) to drink from; (b) as a building block; (c) to create a wire telephone; (d) as a house or boat; or (e) as a toy. Examples of ideas that were coded as original are to use a tin can "to draw a circle with", "as a cutting tool", "as wall decoration", and "as a source of inspiration". This classification of ideas as original versus unoriginal is based on extensive research using this task, and frequency counts of how often specific uses are given (e.g., Torrance, 1962). As such, the current classification of ideas as original versus not original reflects frequency of occurrence more than some subjective rating by independent coders. Furthermore, it is important to note that with this task we assessed two out of the three components of creative performance – fluency (the number of unique uses mentioned) and originality (frequency-based classification, see above) but not cognitive flexibility (the number of distinct cognitive categories used to sample ideas and uses from). We refrained from developing a category system because

participants generated relatively few unusual uses and unlike brainstorming research where usually many more ideas are generated (and substantial cognitive categories can be construed) we were unable to develop a set of meaningful categories. We return to this in the General Discussion.

2.2.2. Results and discussion

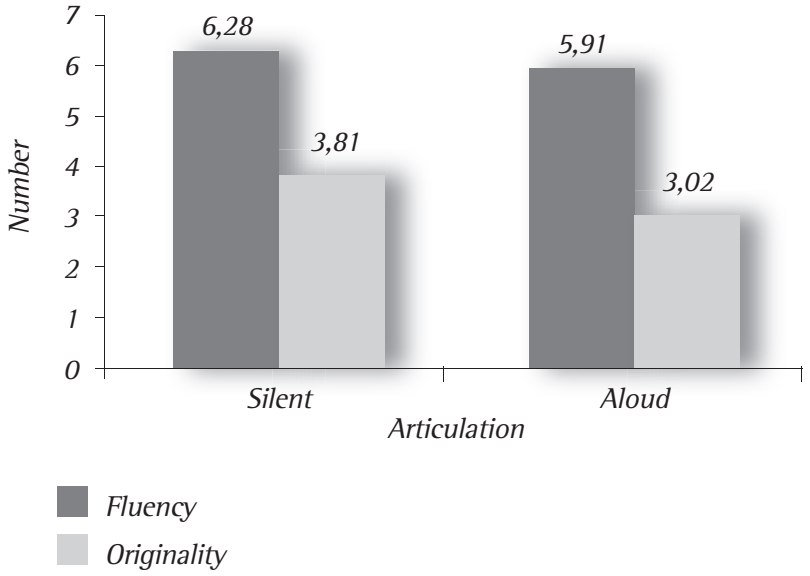
The reliability of the judges' evaluations was high (Cronbach's = 0.99 for the number of ideas, and = 0.92 for the number of original ideas). For further analysis of the number of ideas (fluency) and the number of original ideas (originality) the counts of the four judges were averaged.

Consistent with research showing that quantity breeds quality, the correlation between fluency and originality was positive and significant, r (44) = .87, $p < .001$.

Results are summarized in figure 2.1. Participants in the thinking aloud condition produced fewer ideas than those thinking silently, but this difference was not significant, t (43) = 0.89, $p < 0.38$. Consistent with the idea that thinking aloud hinders creativity, participants in the thinking aloud condition produced less original ideas than those thinking silently. This difference was significant, t (43) = 2.13, $p < .05$.

Figure 2.1

Effects of articulation on fluency (number of unique ideas) and originality (number of original ideas); Experiment 1



2.3. EXPERIMENT 2

Experiment 1 showed that thinking aloud reduces the generation of original ideas. This finding is inconsistent with the idea that thinking aloud activates more constructs, or improves working memory and thereby enhances creativity. Results are, in contrast, consistent with the idea that thinking aloud requires processing in terms of translating thoughts into words and sentences (e.g., Kim, 2002; e.g., Levelt, 1989; Schooler et al., 1993). In addition to this, thinking aloud may lead to an attempt to adapt expression given that others can observe (hear) the thoughts expressed (James et al., 2000; Plant et al., 1985; Szymanski et al., 1992). Even more, thinking aloud may enhance the mere feeling of being observed and stimulate the "spotlight effect" where one feels being observed and evaluated by others even though these others are not present and will not be able to evaluate (cf., Gilovich, Medvec, & Savitsky, 2000). Thus, Experiment 1 corroborates that thinking aloud reduces creativity, and this may be due to lowered processing capacity, to increased evaluation apprehension, or both.

In Experiment 2 we examined the moderating role of individual differences in evaluation apprehension on the effects of articulation on creative performance. As mentioned, thinking aloud may raise people's awareness of others, and increases people's need to adapt to the norms and values these others (presumably) endorse. Work on self-monitoring (Snyder, 1974; Snyder & Gangestad, 1986) has, however, shown that individuals chronically differ in both their sensitivity to what others think of them and in their ability to adapt to these expectations (Lennox & Wolfe, 1984). Whereas some individuals are highly concerned with what others think of them, other individuals are less concerned with other people's evaluations. Likewise, whereas some individuals have strong ability to adapt to other people's expectations, other

individuals have greater difficulty adapting. These two components of self-monitoring – sensitivity to others, and ability to adapt – are theoretically and empirically distinct, in that individuals can be very sensitive yet highly able to adapt, or very sensitive and quite unable to adapt (see e.g., Briggs, Cheek, & Buss, 1980; Gabrenya & Arkin, 1980; Miller & Thayer, 1989).

If thinking aloud reduces creativity because it raises social pressures and concern with evaluation, thinking aloud should reduce creativity especially among those individuals high in sensitivity to what others think of them. Those individuals low in sensitivity should be less influenced by elicitation procedure (i.e., thinking aloud vs. thinking in silence) when generating creative ideas. Furthermore, the above work on self-monitoring suggests that sensitivity becomes an issue especially when individuals have low ability to adapt to others. When sensitivity is paired to low ability, social context absorbs more processing capacity than when sensitivity is paired to high ability. In other words, we predicted a three-way interaction among articulation, sensitivity, and ability: Compared to thinking in silence, thinking aloud reduces creative ideation when individuals are sensitive to others, especially when they have low rather than high ability to adapt to others.

Before moving on it is important to note that past work on elicitation method (thinking aloud versus thinking in silence) has not been related to work on self-monitoring, social anxiety, or related constructs – effects tend to be explained in cognitive rather than social-psychological terms and processes. Vice versa, research on group brainstorming has been concerned with social anxiety and self-monitoring but those studies did not vary elicitation method. Put differently, the current experiments contribute to both areas of research, by articulating the effects of elicitation and by specifying the social psychological conditions moderating these elicitation method effects.

2.3.1. Method

Participants and experimental design. One hundred and fifty three first-year students at the University of Amsterdam participated in the experiment for course credits. Participants were randomly allocated to a think-aloud or a think-in-silence condition and performed the same creativity task as in Experiment 1. Prior to the experiment, participants completed self-monitoring scales tapping both self-monitoring ability and sensitivity to others. Dependent variables were the number of unique ideas, and the number of original ideas generated.

Procedure and independent variables. Students participated in groups of 4 – 6 individuals. Upon arrival in the laboratory, participants were seated in individual cubicles. The experiment began with the assessment of self-monitoring. To measure self-monitoring, we used the Lennox and Wolfe (1984) 13-item Revised Self-Monitoring Scale. The scales have good psychometric qualities (Larkin, 1987; Lennox et al., 1984; Shuptrine, Bearden, & Teel, 1990), and previous work with a Dutch version of the scales corroborates this (Steinel, 2004). Examples of items in the "ability" scale are (a) I have the ability to control the way I come across to people, depending on the impression I wish to give them; (b) When I feel that the image I am portraying isn't working, I can readily change it to something that does; and (c) Once I know what the situation calls for, it's easy for me to regulate my actions accordingly. Examples of items in the "sensitivity" scale are (a) In conversations I am sensitive to even the slightest change in the facial expression of the person I'm conversing with; (b) I can usually tell when others consider a joke to be bad taste, even though they may laugh convincingly; and (c) I can usually tell when I've said something inappropriate by reading it in the listener's eyes. Principal Component Analysis with Varimax Rotation

showed that the 13 items loaded on two factors as expected, and within scales ratings were averaged into an index for "self-monitoring ability" and "self-monitoring sensitivity."

Hereafter, we proceeded as in Experiment 1. In one set of sessions (N = 77), participants in both the think-aloud and think-in-silence conditions were given small notes every 1½ minute to remind them of sticking to the think-aloud and think-in-silence instruction, to prevent those thinking-aloud from falling silent, and to treat those thinking-in-silence similarly as those thinking-aloud. In another set of sessions (N = 76), these notes were not given, and participants worked undisturbed for the entire period. Preliminary analyses showed no main or interaction effects involving type of session (all ts < 1.07, all ps > .28), and this factor is not discussed further. Upon completion of the creativity task participants were thanked, debriefed, and dismissed.

As in Experiment 1, three judges independently coded individual responses to the unusual-uses test for (1) the number of ideas and (2) the number of original ideas. Interrater reliabilities were excellent (see table 2.1), and average ratings across judges were used in the analyses.

2.3.2. Results and discussion

Descriptive statistics. Table 2.1 gives the zero-order correlations, means and standard deviations for all variables in this study. As can be seen self-monitoring ability and sensitivity were moderately correlated, and self-monitoring ability was negatively correlated with the number of original ideas. Consistent with Experiment 1 and other work showing that quantity relates to quality (Diehl et al., 1987; Nijstad et al., 2003a), the number of solutions was strongly and positively related to the originality of the ideas.

Table 2.1

Means, Scale Reliabilities, Standard Deviations, and Zero-Order Correlations for All Study Variables in Experiment 2 (N=153)

	M	SD	1	2	3	4
1. Ability to Modify Self-Presentation	27.42	5.16	0.85	0.30**	-0.05	-0.19*
2. Sensitivity to Other's Expressive Behaviour	25.00	3.82		0.78	-0.03	-0.07
3. Number of Ideas	7.03	3.93			0.99	0.76*
4. Number of Original Ideas	3.60	2.14				0.98

Note: Scale reliabilities (Cronbach's alpha) are given on the diagonal;

*: $p < 0.05$;

**: $p < 0.01$

Number of ideas. To examine whether the number of ideas generated varied as a function of articulation, ability to modify self-presentation, and sensitivity to others' expressive behavior, a multiple hierarchical regression

was computed with number of ideas as the dependent variable, and the main effects and interaction among articulation, ability to modify self-presentation, and sensitivity to other's expressive behavior as the independent variables. Following Aiken and West (1991), elicitation method was dummy coded (thinking aloud = 1) and continuous predictor variables were centered around their mean before the interaction terms were calculated, and before they were entered into the regression equation.

For the number of ideas (fluency), the regression model was not significant, $F(7, 145) = 0.66$, $p < .67$, $R^2 = .04$ (adjusted $R^2 = .02$). Regression weights are summarized in table 2.2. Apart from a marginally significant three-way interaction, no single regression weight was significant. Exploratory follow-up analyses including simple slope tests revealed no significant effects whatsoever (all ts < 1.20, all ps > .25), so that it is concluded that articulation, ability to modify self-presentation, and sensitivity to others' expressive behavior, alone or in combination, has no significant influence on the number of ideas generated. This conclusion is consistent with the observation in Experiment 1 that elicitation method had no effect on fluency.

Originality of ideas. To test our prediction about creativity, a multiple hierarchical regression was computed with number of original ideas as the dependent variable, and the main effects for, and interactions among articulation, ability to modify self-presentation, and sensitivity to others' expressive behavior as the independent variables. This regression model was significant, $F(7, 145) = 4.35$, $p < .001$, $R^2 = .20$ (adjusted $R^2 = .15$). Regression weights are summarized in table 2.2. Consistent with Experiment 1, we found a significant main effect for articulation. Participants in the think-aloud condition generated fewer original ideas ($M = 3.87$) than those in the think-in-silence condition ($M = 4.68$), $t = 2.01$, $p < .05$ (see also figure 2.2).

Table 2.2

Regression of number of ideas and originality of ideas on articulation, ability to modify self-presentation, sensitivity to other's expressive behaviour, and their interactions; Experiment 2 (N=153)

	Number of ideas				Originality of ideas			
	B	(SE)	b	t	B	(SE)	b	t
Constant	7.51	(3.03)		2.48**	1.64	(1.88)		0.38
AMSP	-0.03	(0.11)	-0.00	-0.01	0.04	(0.06)	0.04	0.34
SOEB	-0.01	(0.11)	-0.04	-0.27	0.01	(0.07)	0.07	0.61
Articulation (Art)	-0.54	(0.62)	-0.08	-0.86	-0.77	(0.39)	-0.16	-2.01**
Art*AMSP	-0.04	(0.14)	-0.04	-0.43	-0.03	(0.09)	-0.04	-0.41
Art*SOEB	-0.08	(0.16)	-0.06	-0.52	-0.09	(0.10)	-0.11	-1.00
AMSP*SOEB	0.02	(0.18)	0.08	0.76	-0.01	(0.02)	-0.04	-0.43
AMSP*SOEB* Art	-0.05	(0.03)	-0.21	-1.90*	-0.04	(0.02)	-0.22	-2.12**

Note.

AMSP = Ability to Modify Self-Presentation;

SOEB = Sensitivity to Other's Expressive Behavior;

Art = Articulation (dummy coded, with 1 = think aloud; 0 = think silent);

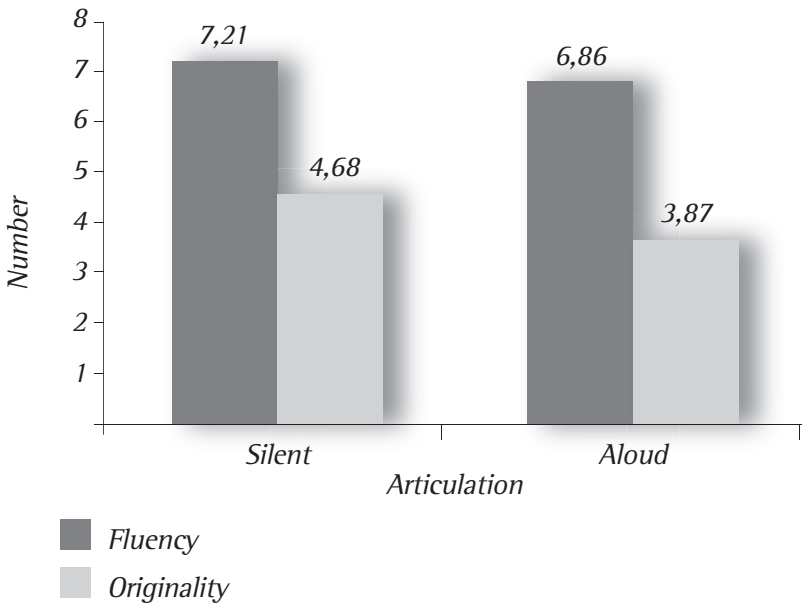
* $p < .10$

** $p < .05$,

*** $p < .01$ ($N = 153$).

Figure 2.2

Effects of articulation on fluency (number of unique ideas) and originality (number of original ideas); Experiment 2



As predicted, this main effect for articulation was qualified by a three-way interaction among articulation, ability to modify self-presentation, and sensitivity to others' expressive behavior. To interpret the complex three-way interaction we ran separate regressions within the think aloud, and the think silent conditions. In each case, the main effects for, and interactions among ability and sensitivity were entered as the independent variables. Originality of ideas served as the dependent variable. In the think-in-silence condition, the regression model was not significant, $F(3, 72) = 0.64$, $p < .59$, $R^2 = .03$, and no single regression weight reached significance. When thinking in silence, slopes for ability to modify self-presentation do not differ as a function of sensitivity to other's expressive behavior, Bs $< |0.01|$, ts < 1, ns.

In the think-aloud condition, the regression model was significant, $F(3, 76) = 2.91$, $p < .05$, $R^2 = .11$. Inspection of the regression weights only revealed a significant effect for the interaction between ability and sensitivity, $B = -.45$, $t = -2.33$, $p < .025$. Test for simple slopes revealed that when the sensitivity to others' expressions was low, ability to adapt had no significant relationship with originality, $B = 0.09$, $t = 0.92$, $p < .36$. As predicted, however, when sensitivity was high, low ability to adapt negatively related to originality, $B = -0.30$, $t = -2.26$, $p < .027$. In other words: When thinking aloud, the number of original ideas is reduced for those with high rather than low sensitivity to other's expressive behavior when the ability to self-monitor is low rather than high.

2.4. CONCLUSIONS AND DISCUSSION

Although some work in both cognitive and social psychology suggested that thinking aloud helps creativity, the current set of experiments extends emerging research showing that thinking aloud reduces creative ideation. Furthermore, Experiment 2 shows that thinking aloud reduces creativity especially when individuals are highly sensitive to others' expressions and low in ability to adapt to these expressions. These results not only corroborate that thinking aloud hinders rather than helps ideation, it also provide interesting cues as to when, and for whom this effect of articulation is particularly pronounced. For instance, that sensitivity only hurts creativity when ability is low suggests that for some individuals more than for others the real or imagined evaluation by others taxes cognitive capacity and reduces creative performance. Especially among those individuals high in sensitivity to others' expressions and low in the ability to adapt to others, the mere feeling that "someone is looking over my shoulder" may be enough to reduce creative performance.

A viable explanation for the results of the two experiments together is that thinking aloud requires more cognitive capacity than thinking silently, in part because thinking aloud activates social and contextual concerns. As such, our results resonate well with those obtained by Camacho and Paulus (1995) and Connolly et al. (Connolly et al., 1990) who showed that social anxiousness and identifiability reduces creativity in group brainstorming. However, we believe that our work adds to these findings in three critical ways. First, we demonstrated that effects of self-monitoring were present only when people thought aloud instead of in silence. Second, we demonstrated that these effects emerge in individual settings when people work alone.

Third, and finally, our work showed that social pressures have greater impact among those with low ability to adapt to others' (expected) expressions. This finding is important because it suggests that social anxiousness and identifiability impact creative ideation and brainstorming performance especially when people have difficulty adapting, and not when people easily adapt to others. This implication may be tested in brainstorming groups composed of members with high vs. low sensitivity to others' expression, and high vs. low ability to modify their behavior. On the basis of current results we would predict production losses especially when group members' sensitivity is high and their ability to adapt is low.

The finding that self-monitoring moderated the effects of elicitation method on creative thinking may seem inconsistent with the finding by Diehl and Stroebe (1987, 1991) that social anxiety and evaluation apprehension had little effect on individual and group brainstorming. This apparent inconsistency can, however, be easily understood when we realize that their studies did not differentiate between the level of social anxiety (or evaluation apprehension) and the ease or difficulty in managing and coping with that social anxiety.

Unlike this previous work, we explicitly distinguished between the extent to which people are sensitive to others and their ability to adapt to others. We argued and found that only when people have low ability to adapt sensitivity exerts its influence. Put differently, the current work contributes to our understanding when and why self-monitoring, social anxiety, evaluation apprehension and related constructs do, and do not, influence creative performance and the relationship between some antecedent condition (like elicitation procedure) and creativity.

Whereas in the present work ease of adaptability and sensitivity to others' expressions were conceived as chronic individual differences, situations may have a similar function. That is, some situations may make people more sensitive to others' expressions. Whether people work alone or in a group, and whether their contribution can be identified or not are just two examples. Also, the ability with which one adapts to others may be influenced by the situation. For example, under high time pressure people have greater need for cognitive closure, and tend to be less creative (Chirumbolo, Livi, Manetti, Pierro, & Kruglanski, 2004). Perhaps that time pressure reduces the adaptability component as well, and thereby moderates the effect of thinking aloud on creative idea generation. Obviously, we are speculating here and research is needed to test effects of situational constraints on creativity when people think aloud, or in silence.

In developing our confirmed prediction that thinking aloud hurts creative performance, we relied on work by Schooler et al. (1993), Kim (2002), and Fleck and Weisberg (2004). We reasoned that verbal overshadowing may not transfer comfortably from insight problems to creative performance because creative performance requires cognitive flexibility, divergent thinking and fluency, as well as being original. Our results showed that although fluency

and originality were strongly correlated, only originality was influenced by articulation and fluency was not. Because only originality was also influenced by the interaction among articulation, self-monitoring sensitivity and ability, it may be that fluency and originality are highly correlated but not causally linked. Both aspects of creativity co-exist and are partially driven by the same process, and partially driven by different processes (Rietzschel, Nijstad, & Stroebe, 2006). Future research is needed to further explore this possibility, to further understanding of the psychological mechanisms underlying quantity and quality of ideation.

Related to the question of how quantity and quality are related is what the role of the third component of creativity not considered in these experiments would be – how does elicitation method influence cognitive flexibility and will self-monitoring moderate this relationship in much the same way as was found for originality? Flexibility, fluency, and originality are interrelated yet distinct components and to our knowledge there is no clear-cut theoretical account that allows one to predict a priori whether fluency, flexibility, or originality will be affected and how the three are interrelated in any specific context (Rietzschel, De Dreu, & Nijstad, 2006). Thus, it largely is an empirical issue and future work on elicitation procedures and thinking aloud would benefit from including assessments of cognitive flexibility as well.

Recall that Wetzstein and Hacker (2004) found that reflective verbalization increased the quality of object design, and we interpreted this finding as suggesting that thinking aloud may stimulate creativity. Clearly, our results suggest otherwise, but this begs the question what then explains the discrepancy between the present findings and those reported by Wetzstein and Hacker. One possibility is that there is a fundamental difference in the psychological processes underlying creative performance and object design.

While possibly true, an alternative is related to the fact that in the current experiments participants had to give a concurrent verbal report of their cognitive activity, whereas in the Wetzstein and Hacker study, participants interrupted their design activity to give a verbal report, and thereafter continued with their design. Perhaps that the timing of verbalization makes a critical difference, and future research could test this possibility. Based on our analysis, we would predict that concurrent verbalization undermines creativity, and that intermediate verbalization may help.

To some extent our work was motivated by the observation that in applied settings people are often stimulated to think aloud because this would help them solve their problems and promote creativity in the work place. Although social sharing of creative ideas may promote creativity because people get exposed to new information, new perspectives, and new mental categories (cf., Nijstad & Paulus, 2003), the present work shows that thinking aloud hurts creativity. Whether in the end the net result of thinking aloud and social sharing is positive remains to be seen. At the very least, the recommendation to think aloud should be made only to those individuals that are low in sensitivity to others' expressions, or to those with high ability to adapt. Otherwise, thinking aloud hurts rather than helps creativity.

CHAPTER 3
INTERMEZZOS FOR THINKING ALONE: HOW SUSPENDING GROUP DEBATE CAN ENHANCE GROUP PROBLEM SOLVING PERFORMANCE

Abstract

Although the management literature assumes that group debate enhances group performance, we propose that group performance can under certain conditions benefit from temporarily *suspending* debate. Our core insight is that for teams with at least one team member with relatively low extraversion, holding an intermezzo for thinking alone during a group meeting increases group problem solving performance, i.c. increases the number of ideas generated by the team, without harming the average quality of each idea. These predictions were supported by findings from a randomized experiment with 45 real (not ad hoc) teams working on a real problem at a university.

3.1. INTRODUCTION

There is a significant debate in the management literature about the impact of group debate on team performance. For example, Simons, Pelled and Smith (1999) find that debate characterized by defending viewpoints and challenging those of others allows teams to capture the benefits of diversity. Postmes, Spears and Cihangir (2001) find that critical debate, rather than debate focused on consensus, positively affects information sharing, a key factor influencing group performance. Jehn and Mannix (2001) find that debate characterized by *moderate* task conflict at the midpoint of group interaction positively influences group performance. Barkema and Chyrkov claim that constructive debate mediates the effect of top management team diversity on strategic innovation, such as technological

and bureaucratic innovation, entry into new product markets, and so on (Barkema et al., 2007).

The underlying assumption in such and other management literature is that group debate is more effective than individuals working alone without interaction. Also practitioners tend to think that group interaction, e.g. in group brainstorming, is more effective than working alone (Paulus, Larey, & Ortega, 1995). The management literature about group debate is suffering from an important gap: there is no recognition that, rather than only benefiting from improving debate, teams might benefit from (temporarily) suspending debate.

Our study uses a social cognitive psychological lens to study the advantages and disadvantages of group debate. Our core insight is that temporarily suspending debate, i.e. holding an intermezzo for thinking alone during group meetings, can improve actual group problem solving performance, specifically the number of ideas generated (*without* harming the quality of each idea generated), for teams with one or more members relatively low in extraversion.

We believe that our insight also has value for practitioners. Although prior research has established the benefits of thinking alone, this insight has not been put into practice: group sessions to generate ideas ('group brainstorms') are still used widely. This may be because of the illusion of group effectivity, the false perception that groups are more effective than the same number of individuals thinking alone in generating ideas (Paulus & Dzindolet, 1993; Paulus et al., 1995; Stroebe, Diehl, & Abakoumkin, 1992), and may be because most people derive more satisfaction, more enjoyment, from generating ideas in a group than generating ideas alone (Diehl et al., 1991;

Paulus et al., 1995; Stroebe et al., 1992). Holding an intermezzo for thinking alone allows groups to work as groups whilst simultaneously capturing the benefits of working alone for idea generation. Specifically, whenever a team needs to generate ideas (and given the importance of innovation in the current business context, this need arises often), and if at least one of the team members is relatively introverted, it may pay to hold an intermezzo for thinking alone, e.g. by spending 5 minutes writing down ideas whilst staying seated at the meeting table. Such an intermezzo can substantially increase the number of ideas generated (can even double it, in our study).

Our theory is supported by a randomized experiment (Aronson, Wilson, & Brewer, 1998; Cook & Campbell, 1979) with 45 real teams (i.e. groups of individuals with a history of collaboration) with 206 team members working on a real problem (i.e. lack of desk space at Tilburg University).

In the following sections we first provide conceptual background, then develop our theory and hypotheses, subject these to a test, and discuss the results.

3.2. CONCEPTUAL BACKGROUND

We review literature on problem solving in groups, on advantages of group debate and of suspending group debate, and on extraversion (a moderator in our study).

3.2.1. Problem solving in groups

The problem solving performance of groups (e.g. number of solution ideas, solution quality and problem solving speed) affects overall group performance (e.g. in terms of product quality, development time and development cost for NPD teams) (Atuahene-Gima, 2003). The number of solution ideas generated is traditionally considered important for the quality of solutions: the more ideas generated, the higher the likelihood of generating a high quality idea, using a variation-selection or funnel logic (Campbell, 1969; Nijstad, 2000; Simonton, 1998, 1999). Hence, we believe that advancing the understanding of the antecedents of the number of (solution) ideas generated by a group is an important avenue for research.

Building on prior studies (Ancona & Caldwell, 1992; Atuahene-Gima, 2003; Hinsz, Tindale, & Vollrath, 1997; Keller, 2001; Reagans & Zuckerman, 2001), we conceptualize team problem solving as cognitive information processing, consisting of cycles of three processes 1) information sharing inside the team, 2) idea generating (e.g. problem solutions, decision alternatives) and 3) idea selecting. For example, after team members from different functional departments have accessed information through external communications, they share their ideas in a group meeting. In that meeting, individual team members personally combine the ideas shared by others and own ideas into new ideas and share these again in the group. Others may then in that

meeting combine these ideas further with other ideas and share the insights in the group again. Finally, the group selects the good ideas.

3.2.2. Advantages of group debate: information sharing (phase 1) and idea selection (phase 3)

Other research has established that information sharing is important for group performance (Postmes et al., 2001; Stasser, 1992; Stasser, Vaughan, & Stewart, 2000). Especially when information and perspectives of group members are heterogeneous, deep information sharing (i.e. explaining and defending own perspectives and challenging that of others) positively influences group performance (Simons et al., 1999). Such deep information sharing is made possible by group debate, hence one of the advantages of group debate over individuals working alone is the potential offered for deep information sharing.

Research has also found that groups are better than individuals at selecting ideas (Laughlin, Vanderstoep, & Hollingshead, 1991; Laughlin, Zander, Knievel, & Tan, 2003). These studies found that groups are more likely than individuals to recognize good ideas and to reject bad ideas. Hence, another advantage of group debate over individuals working alone is the ability to more reliably select the best ideas.

3.2.3. Advantages of suspending group debate: idea generation (phase 2)

Alex Osborn (1953) proposed to use brainstorming in groups to enhance idea generation. However, social cognitive psychology research has found in the last two decades that real groups produce fewer ideas than nominal groups, i.e. an equivalent number of individuals working alone, do (Diehl et al., 1987, 1991; Mullen et al., 1991; Nijstad et al., 2003b; Nijstad, van Vianen, Stroebe, & Lodewijkx, 2004; Stroebe et al., 1994; Stroebe et al., 1992). Various explanations have been offered for the performance disadvantage of groups vs. an equivalent number of individuals, including evaluation apprehension (members are cautious in expressing new ideas because of the following evaluation of the ideas by others), free riding (members let others generate and share ideas), and production blocking (Diehl et al., 1987, 1991): the production of ideas by individuals is blocked in groups because only one person can talk at a time and others need to pay attention in order to notice when they can state their own ideas and need to focus on remembering the idea they want contribute. As a result of this they are blocked in the production of further ideas. The larger the group the more time each member needs to spend listening to others and the more each member is blocked in his or her production of ideas (ibid).

Recent research found that part of the productivity loss observed in interacting brainstorming groups may be due to inhibited performance of individuals who are uncomfortable with group interaction, i.e. of individuals who are socially anxious (Camacho et al., 1995) or particularly challenged in social situations (Chapter 2). These individuals who are uncomfortable or less able in group settings may even influence others in the group to lower performance in line with the formers' inhibited performance level, in a matching process (Camacho et al., 1995; Paulus et al., 1993).

However, although the research evidence in favour of generating ideas alone rather than in groups is massive, it has not been (and is not likely to be) adopted in practice. This is because, those experiencing individual brainstorming perceive it to be *less* effective than those experiencing group brainstorming (Paulus et al., 1993; Paulus et al., 1995; Stroebe et al., 1992). This is best explained by giving an example: assume individuals generate 4 ideas per minute when brainstorming alone (one idea every 15 seconds), and a group of 5 individuals generates 10 ideas per minute (one idea every 6 seconds). In such a setting, individuals will perceive the group as clearly more effective for generating ideas (an idea every 6 seconds rather than every 15 seconds). However, combining the ideas of 5 individuals working alone and each generating 4 ideas per minute, leads to 20 ideas per minute, excluding overlap perhaps 15 ideas per minute, still clearly more than the 10 ideas per minute the interacting group generated. In the cited studies the effect of eliminating production blocking has always been large enough to offset any losses due to overlap in ideas generated by individuals thinking alone.

The example offers an explanation why nominal groups (individuals thinking alone) can actually outperform groups whilst simultaneously individuals perceive groups to be more productive than individuals thinking alone. The phenomenon that problem solving performance is *perceived* to be lower for individuals working alone than for individuals working together affects the likelihood of continued and extensive use of nominal groups for generating ideas. In addition, the phenomenon that most people achieve more personal satisfaction, more enjoyment, from generating ideas in a group rather than alone (Diehl et al., 1991; Paulus et al., 1995; Stroebe et al., 1992) may explain why generating ideas as a group is still widespread, despite the research evidence that generating ideas alone is more effective.

3.2.4. Extraversion

One personality characteristic relevant to comparing effectiveness of group work versus individual work is extraversion, one of the five most salient personality characteristics (together known as the Big Five). The Big Five, a five factor model of personality, emerged after decades of personality research in the 20th century and is supported by a considerable amount of research (e.g. Costa & McCrae, 1988; Digman, 1989; Goldberg, 1990; McCrae & Costa, 1997; McCrae & John, 1992). Jung (1923) brought the extraversion-introversion dichotomy into common usage, although, as he acknowledges, the concept has a history extending back to Schiller, Nietzsche and others. Jung brought the concepts into common parlance and suggested that extraversion is a matter of attentional orientation: for an introvert the stimuli considered worthy of attention are those in the introvert's own mind, whereas for an extraverted individual what is considered worthy of attention is the outside world.

Importantly, extraverted individuals have been found to be better at multitasking than introverted individuals are (Lieberman & Rosenthal, 2001). They found that, despite the popular notion that introverts are less effective at decoding nonverbal cues in conversation, introverts are as good in nonverbal decoding as extraverts are when such decoding is the only task. When decoding was a secondary task in a multitasking context, introverts exhibited a nonverbal decoding deficit. The lower ability to multitask for those with low extraversion is very relevant in group settings, because group settings often require multitasking, e.g. listening to others, generating own ideas, and monitoring the conversation in order to time the sharing of own ideas.

3.3. THEORY AND HYPOTHESES

As discussed, group debate allows accessing and deep sharing of ideas from diverse sources of information and perspectives, which is not feasible without group interaction, and group debate (as opposed to individuals working alone) leads to better idea selection. However, individuals generate ideas more quickly when thinking alone than when discussing in a group setting. Thus, we propose that allowing teams in their meetings to first share information and generate ideas as a group and then interjecting into the meeting an intermezzo for thinking alone to stimulate idea generation, and then allowing the team time to select the good ideas and generate further ideas based on them, can be beneficial for problem solving performance, specifically the number of ideas generated. Such a sequence allows team members to build on each other's ideas when generating ideas, allows team members to generate ideas alone (i.e. without production blocking), and allows teams to select the good ideas (and possibly to build on these and/or combine these into more advanced ideas). Without an intermezzo for thinking alone, a group does not benefit from the advantages of idea generation by individuals thinking alone (i.e. relief from production blocking).

H1: An intermezzo for thinking alone during a team meeting positively affects the number of ideas generated by the team.

The size of the effect of an intermezzo on the number of ideas generated (hypothesis 1) is likely to depend on the degree to which team members are effective in group settings versus in individual settings. Generating ideas in a group setting requires multitasking, i.e. it requires individuals to both generate ideas, to listen to the ideas of others, and to monitor when it is a good time to share own ideas. An intermezzo for thinking alone provides a relief of the

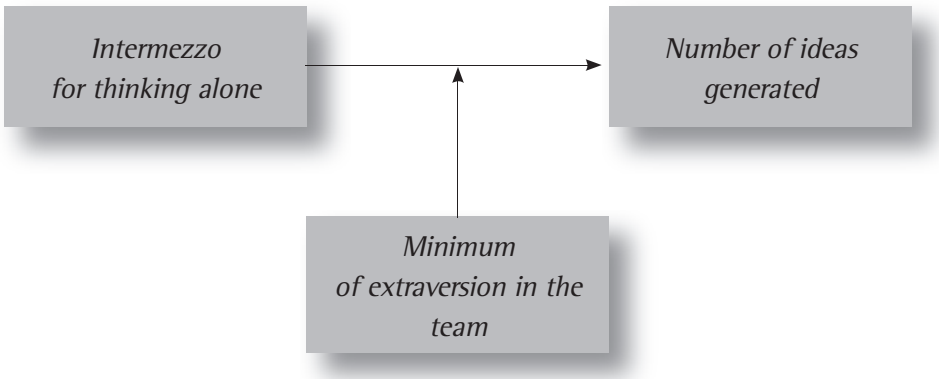
need for multitasking. It allows individuals to focus their entire attention on generating ideas, without having to simultaneously attend to others in the team. Individuals who are low in extraversion are less able to multitask (Lieberman et al., 2001), and tend to be more socially anxious (Kelly, Jones, & Adams, 2002; Leary & Kowalski, 1993) and hence less comfortable and effective in group settings (Camacho et al., 1995). Thus, teams who consist of individuals who are all relatively low in extraversion will benefit from an intermezzo, whereas teams who consist of individuals who are relatively high in extraversion will not benefit, because not having to multitask as a result of having an intermezzo is not useful when one is good at multitasking and because individuals high in extraversion are low in social anxiety and hence their performance is not impaired in group settings.

If just one individual in the team is relatively low in extraversion and hence poor at multitasking, and socially anxious, then this individual will benefit from the team having an intermezzo for thinking alone. This relatively introverted individual will benefit by being able to concentrate entirely on idea generation during the intermezzo, and will generate more ideas than if there were no intermezzo for thinking alone. The higher number of ideas generated by the relatively introverted individual as a result of the intermezzo will enrich the team debate after the intermezzo: these extra ideas of the relatively introverted individual may be combined with ideas of others or may be adopted as team ideas unchanged. Also, the higher number of ideas generated by the relatively introverted team member may affect the performance of the other team members through a matching process. A matching process is the phenomenon that team members adapt performance to that of the least productive member. Paulus and Dzindolet (1993) found evidence for such a matching process in that idea generation performance of individuals in groups was more similar than performance of individuals in

non-interacting groups and that performance of the least productive members was most influential in determining group performance. Individuals low in extraversion are more likely than those high in extraversion to be relatively low in productivity in group settings, given their lower ability to multitask and their higher social anxiety. Hence, when an intermezzo increases the effectiveness of especially introverted individuals, it is probably increasing the effectiveness of the least productive member, and hence increasing the level to which more effective team members match down to. In sum, when the team member with the lowest extraversion is relatively introverted, the intermezzo positively affects the number of ideas generated; otherwise there is no effect. See hypothesis 2 and figure 3.1.

H2: The effect of holding an intermezzo on the number of ideas generated by a team depends on the extraversion of the team member with the lowest extraversion in the team: when at least one or more team members are relatively introverted the intermezzo has a positive effect on the number ideas generated by the team; otherwise there is no effect.

Figure 3.1
Theoretical Framework



3.4. METHOD

3.4.1. Design and sample

Forty-five teams of 4 to 5 business students each (206 students in total), with 2 months of experience working together intensively on an unrelated business simulation game, took part, for course credit, with prizes available for the best teams to increase motivation. Each team took part in a separate session in which they were asked to develop recommendations for how Tilburg University could reduce the shortage of available deskspace for students. The shortage of available deskspace was a real problem, there were no standard right or wrong solutions and there was room for creativity. Hence the task was complex and non-routine; it required a significant problem-solving effort and was thus suitable to test our theory. In addition, students knew the problem and the campus well given their own experience and thus had sufficient knowledge to be able to develop solutions. Half of the teams was randomly allocated to the intermezzo-for-individual-brainstorming condition, the other half to the control condition ("intermezzo for group brainstorming").

We use a randomized experiment (Aronson et al., 1998; Cook et al., 1979) rather than observations or a survey, because 1. creating intermezzos for thinking alone is not (yet) common within group meetings, because 2. when manipulation of conditions and randomisation are possible, experiments offer compelling advantages in terms of internal validity, and because 3. we wanted to keep the task and intermezzo characteristics constant across conditions to enhance statistical validity. We did the experiment in a university setting because 1. we were there able to find a large enough sample of real teams of individuals who had been working together as a team for two months

(rather than having to work with ad-hoc teams), thus enhancing external validity, because 2. we were able to use a realistic task with teams working on a practical problem on campus (lack of desk space) with which they were highly familiar. So, as in companies existing teams (e.g. management teams or other teams) are frequently asked to work on a problem for which they have relevant knowledge, in our setting too real teams were given the task to work on a real problem with which they had real experience. Combined with the fact that we were able to randomize allocation to condition we believe that our method and setting provides both high internal and external validity.

3.4.2. Procedure

The experiment took place in the context of a course organized around a business simulation game. We first let the students work in their teams for two months so that in the experiment we would be dealing with real teams, rather than ad-hoc teams. We then invited each student team to an obligatory session for our current experiment. Two experimenters executed the experiments with the 45 teams in the course of two weeks.

Upon arrival, a student team was seated in a meeting room and was given instructions written on a table display to develop recommendations for reducing the shortage of available tables for studying individually and in groups on the campus of Tilburg University (e.g. in the library). Then the experimenter left the room. After precisely 5 minutes of group discussion the experimenter interrupted the team and asked the team to continue for five minutes to *brainstorm* about possible recommendations, either in silence (individually) (experimental condition 'no group debate') or in group discussion (control condition 'group debate'). We did not give any further

instructions, such as Osborn's brainstorm rules (e.g. deferment of judgment). The experimenter left and returned after 5 minutes, and instructed teams to continue now with the group discussion to develop the best possible recommendation. Note that in order to have an intermezzo for thinking alone interruptions of the group discussion are necessary, but also note that we held similar interruptions in the control condition as well in order to allow us to attribute any found effects to the intermezzo for thinking alone itself and not to any positive effects that interruptions may have per se (e.g. allowing a step back, allowing consideration of a second agenda, cf. Okhuysen (2001)).

After the students completed the task, the experimenters gave them a short survey, held an interactive mini-lecture on groundbreaking research on how to enhance team problem solving performance, thanked the students and asked them to keep the contents of the experiment and their solutions secret for two weeks. The experimenters announced that bottles of sparkling wine would be awarded to teams who developed relatively good solutions in comparison to other teams, thus giving teams an additional incentive to keep their solutions secret for two weeks.

3.4.3. Measures

Number of ideas generated was measured by having two judges count the number of ideas proposed by each team. The Cronbach's alpha of their counts was 0.96 and we created a composite measure by taking the average of the two counts. This approach has been used previously in brainstorming studies (Chapter 2; Diehl et al., 1987, 1991; Goncalo & Staw, 2006; Nijstad et al., 2003b).

Extraversion was measured using the official Dutch version (Harcourt, 2006) of the NEO-FFI, a scale widely used (e.g. Anderson, John, Keltner, & Kring, 2001; Hofmann & Jones, 2005; Porter et al., 2003) to measure extraversion (with 12 items) and the other four personality factors in the Big Five. Cronbach's alpha was 0.8 for this extraversion scale.

3.5. RESULTS

3.5.1. Descriptive statistics

Table 3.1 gives the means, standard deviations, and the zero-order correlations for all variables in this study. Extraversion and the measure for the share of team members with high sensitivity to others and low ability to adapt were correlated, consistent with prior literature (Briggs et al., 1980).

Table 3.1
Descriptive statistics and correlations (n=45)

Variables	Mean	s.d.	1	2
1. Minimum of extraversion	36.42	4.03		
2. Number of ideas	4.06	2.33	-0.11	

*: $p<0.05$ (two-sided)

3.5.2. Main effect of intermezzo for thinking alone

To examine whether holding an intermezzo for thinking alone influenced the number of ideas generated we computed a univariate analysis of variance. We found that the intermezzo increased the number of ideas generated ($F(1,43)=5.05$, $p<0.031$), consistent with hypothesis 1. The mean number of ideas in the individual intermezzo condition was 4.8, approximately 50% higher than in the group intermezzo condition (M=3.3).

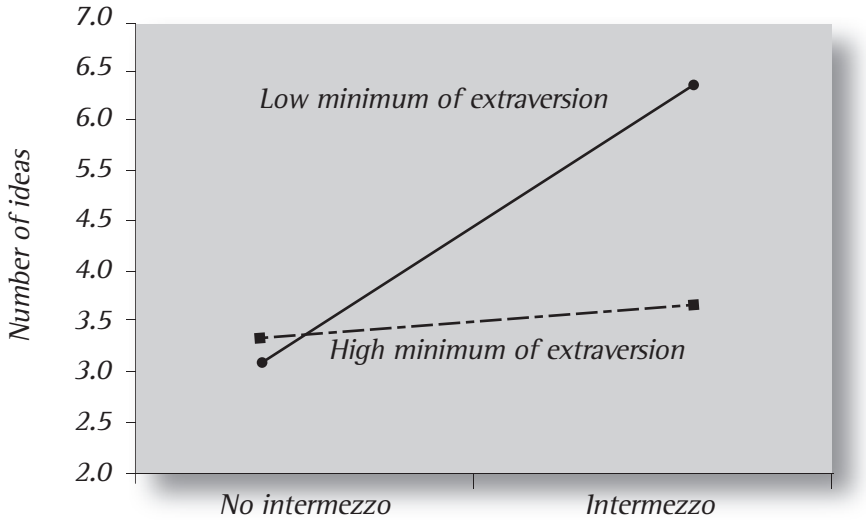
3.5.3. Interactions with the intermezzo for thinking alone

To test the influence of the minimum of extraversion in the team on the effect of the intermezzo for thinking alone we computed a linear regression with number of ideas generated as the dependent and as independents the condition, minimum of extraversion and the interaction (centralized as suggested by Aiken and West (1991)). The model was significant, $F(3,41) = 3.89$, $p < 0.02$. The intermezzo coefficient is positive and significant ($t = 2.71$, $p < 0.01$ two-tailed), the minimum of extraversion is not significant, but the interaction is statistically significant ($t = -2.00$, $p < 0.053$, two-tailed). When minimum extraversion is one standard deviation below its mean, the intermezzo has a positive effect: the average number of ideas is 3.2 without intermezzo for thinking alone, and 6.3 with intermezzo. When minimum extraversion is one standard deviation above its mean, the intermezzo has no effect: the average number of ideas is 3.5 without intermezzo for thinking alone, and 3.9 with intermezzo (see figure 3.2). We tested the significance of these effects by recentering the interaction term in the regression: we first centered the minimum of extraversion component of the interaction term on one standard deviation below the mean of minimum of extraversion, and reran the regression. The coefficient of the intermezzo condition was highly significant ($t = 3.3$, $p < 0.003$ one sided). Second, we centered the minimum of extraversion component of the interaction term on one standard deviation above mean of minimum of extraversion, and reran the regression. In this case the coefficient of the intermezzo condition was not significant ($t = 0.49$, $p < 0.7$ two-sided).

For completeness, we also tested the effect of the intermezzo when the minimum of extraversion was at the level of the average extraversion in the entire sample of 229 individuals (not significant, $p < 0.83$), and when it was

at the level of one standard deviation below that of the average extraversion in the entire sample (significant, $p < 0.045$).

Figure 3.2
Interaction of Intermezzo and Minimum of Extraversion of Team Members



3.6. CONCLUSIONS AND DISCUSSION

Practitioners and management scholars alike *assume* that group debate is important for group (problem solving) performance. We, however, proposed that temporarily suspending group debate by holding an intermezzo for thinking alone can be good for group problem solving performance, and hence for overall group performance. Specifically, we believe that group debate is important for information sharing and idea selection, and that suspending group debate is important for idea generation. We have theorized

about how to let teams combine the benefits of debate and of suspending debate. We believe that it is desirable to let a period of group debate (for sharing information) be followed by an intermezzo for thinking alone (for idea generation based on shared information and own information), followed again by a period of group debate (for sharing new ideas, combining them further and selecting the best ideas). We predicted a main effect of such a temporary suspension of group debate during a group meeting on group performance as well as an interaction effect with the extraversion of the least extraverted team member.

What we find is that holding an intermezzo for thinking alone indeed positively and significantly affects the number of ideas generated: teams with one or more team members with relatively low extraversion generate nearly twice as many ideas than when such teams would not hold an intermezzo for thinking alone. In a metareview of brainstorming studies, Mullen and colleagues (1991) found that non-interacting groups on average generate two times more ideas than normal groups. In our study we were able to achieve a similar two-fold increase in number of ideas generated, with just a 5 minute intermezzo for thinking alone.

A core assumption underlying this paper is that increasing the number of ideas is useful because it increases the likelihood of generating high quality ideas. This may be false if increased quantity comes at the cost of decreased quality. In order to test this, we collected and analyzed some additional data. We measured two aspects of quality, i.e. the practicality of an idea and the originality of an idea. We asked judges to rate the practicality of each idea, defined as the extent to which an idea is likely to be implemented, on a scale of 1-5 (cf. Goncalo et al., 2006). Cronbach's alpha of the ratings of the two judges was good (0.76) and hence we used the average of the ratings of the

two judges as our measure of quality. We measured originality of an idea by counting the number of times an idea was mentioned across the 45 teams, and coded an idea as either original (no other teams had the same idea) or not original. We found no significant correlations between the number of ideas a team generated, the average practicality per idea of the ideas generated by each team and the average originality per idea (i.e. the share of a team's ideas that was original). We also ran two regressions with respectively average idea practicality and average originality as the dependent variables and the intermezzo condition, minimum of extraversion and their interaction as independents. None of the independents' coefficients was significant. As expected from this pattern of results, similar regressions with as dependent variables respectively the *number* of ideas above average in practicality and the *number* of ideas that is original, did yield significant effects for the intermezzo and the interaction of intermezzo and minimum of extraversion (p's<0.05 two-tailed), when centralized at low minimum of extraversion).

This supports the logic that increasing the number of ideas is a worthwhile pursuit, because if the average quality of ideas is unaffected, generating more ideas will generate more (very) high quality ideas, and because teams are relatively effective at rejecting low quality ideas and identifying the high quality ideas (Laughlin, Hatch, Silver, & Boh, 2006; Laughlin et al., 1991).

It would be worthwhile to repeat this study, with teams of managers in an organization and without the somewhat artificial time constraints (e.g. no fixed length of time for the intermezzo, or for the discussion periods before and after the intermezzo. In addition, it would be interesting to measure information sharing and idea selection. For instance, after allowing teams to generate as many ideas as they can, a phase for idea selection could be added, in which teams select one single idea (this would allow measuring

the effect of the intermezzo directly on the quality of the idea remaining after group selection). Finally, in a next study it would also be powerful to measure idea generation before and after the intermezzo.

We believe we have combined important ideas into a theory of group meetings that will help innovating teams improve their performance. Our notion of intermezzos for thinking alone in order to increase the number of ideas teams generate should be highly valuable for practitioners: when a team (e.g. a management team, an R&D team, a new product development team, a strategy development team, an organizational improvement team) is in need of more good ideas (which is often the case in the current business context in which the need for innovation is high) and if at least one team member is relatively introverted, holding an intermezzo for thinking alone as opposed to continuing group discussion may substantially increase (even double!) the ideas generated, without requiring a lot of time (e.g. just 5 minutes) (and despite the fact that thinking alone may require more discipline than group debate). Hence, we have identified a highly efficient way for managers to increase team creativity: using an intermezzo can dramatically increase team creativity, but requires no financial resources, and only 5 minutes of the time of human resources on the team.

CHAPTER 4
THE EFFECT OF GROUP DEBATE ON STRATEGIC DECISION-MAKING ABOUT INNOVATION

Abstract

This paper adds to the debate about strategic decision making about innovation by studying the effect of debate on the type of decision taken (adopting an incremental vs. a radical innovation for market launch). Building on a number of strands of cognitive psychology and social psychology literature, our core insight is that for groups consisting of members with relatively low ability to modify self-presentation (and hence reduced available cognitive capacity in social settings and low ability to express thoughts and feelings), debate *decreases* the likelihood of deciding for a radical innovation (as opposed to for an incremental innovation), whereas for groups consisting of members with relatively high ability to modify self-presentation, group debate *increases* this likelihood. This was supported by findings from a randomized experiment with 39 real (not created ad-hoc) teams in an academic context.

4.1. INTRODUCTION

There is a major debate on the antecedents and consequences of various dimensions (such as speed or comprehensiveness) of strategic decision making (e.g. Baum & Wally, 2003; Dean & Sharfman, 1996; Eisenhardt, 1989; Eisenhardt & Zbaracki, 1992; Forbes, 2005; Fredrickson, 1984; Hiller & Hambrick, 2005; Hough & White, 2003; Korsgaard, Schweiger, & Sapienza, 1995; Mintzberg et al., 1976; Nutt, 1984). Key findings include the notion that the effect of strategic decision comprehensiveness on performance is moderated by the level and type of environmental uncertainty (Atuahene-

Gima & Li, 2004; Fredrickson, 1984), that strategic decision making speed affects performance (Baum et al., 2003; Eisenhardt, 1989; Judge & Miller, 1991; Mintzberg et al., 1976), and that said speed is affected by individual characteristics of CEOs such as age, experience, cognitive ability (Forbes, 2005; Wally & Baum, 1994) and by organizational characteristics such as centralization and formalization (Baum et al., 2003; Wally et al., 1994). In addition, a number of explorative studies has been done to enhance understanding of the processes of strategic decision making (Bourgeois & Eisenhardt, 1988; Mintzberg et al., 1976; Nutt, 1984, 2002; Papadakis, Lioukas, & Chambers, 1998; Rajagopalan, Rasheed, Datta, & Spreitzer, 1998; Roberto, 2004).

There is also a an extensive literature about the performance effects of group debate (Chapter 3; Barkema et al., 2007; Jehn et al., 2001; Postmes et al., 2001; Simons et al., 1999). However, there is no literature about the effects of debate on strategic-decision making. This is an important gap because an essential part of the process leading up to strategic decisions is the debate of reasons for and against decision options. Strategic decisions, i.e. commitments to action that are important in terms of the actions taken, resources committed or precedents set (Mintzberg et al., 1976), are sometimes made after extensive debate about the reasons for each decision option and sometimes without such debate or only little debate. Another gap that we hope to fill is the lack of literature about the effects of group debate on the type of innovation adopted, specifically the extent to which adopted innovations are incremental vs. radical.

Our study aims to start filling these gaps by combining the insights of various strands of cognitive psychology literature on verbalization of reasons and the social psychology literature and applying these insights in the context of

strategic decisions about innovations. Specifically, our core insight is that debate may produce a bias to making strategic decisions in favor of adopting incremental innovations as opposed to radical innovations, and that this may especially be the case when team members have low ability to modify-self presentation which makes the social setting cognitively taxing and is associated with low ability to express thoughts and feelings. This bias could result from verbal overshadowing, the phenomenon that verbalizing reasons leads to a bias towards choosing decision options that are supported by relatively easily verbalized reasons as opposed to decision options that are supported by relatively difficult to verbalize reasons (Fiore & Schooler, 2002; Schooler, 2002; Schooler et al., 1993; Wilson et al., 1993; Wilson & Schooler, 1991). The reasons for why an incremental innovation is useful are usually easier to verbalize than those for a radical innovation (e.g. the characteristics of customers interested, the product value, the costs and the characteristics of competition are usually easier to verbalize for an incremental innovation than for a radical innovation), whereas the reasons against introducing any innovation are usually easy to verbalize (e.g. "there is no proven potential"). Hence, given verbal overshadowing, we theorize that verbalization of reasons will lead to a bias towards selecting incremental innovations over radical innovations, especially when team member's average ability to modify self-presentation is low. When such ability is high, we expect that group debate will make reasons for a radical innovation option more salient, and that such verbal activation will lead to a shift of support toward the radical innovation decision option.

We use a randomized experiment (Aronson et al., 1998; Cook et al., 1979) with 39 real teams (178 individuals who have worked in these teams for 2 months) at Tilburg University.

Our findings are also valuable for practitioners. Our study suggests that when an organization creates a team that needs to make decisions about which innovation ideas to pursue (e.g. a steering committee taking decisions in the context of innovation pipeline management, or a research or NPD team, that in the course of its work decides to pursue certain innovation ideas and abandon others), management should pay attention, when selecting people for the team, to the ability of individuals to modify their self presentation. When the objective is to stimulate radical innovation, high ability is desired, when the objective is to stimulate incremental innovations, low ability to modify self-presentation is desired (assuming that these teams engage in debate before taking decisions). Alternatively, the team should be asked to make decisions without group debate preceding the decision, if a team is high on ability but incremental innovations are preferred by senior management or if a team is low in ability to modify self presentation but radical innovations are preferred by senior management.

In the following sections we first provide conceptual background, then develop our theory and hypotheses, subject these to a test, and discuss the results.

4.2. CONCEPTUAL BACKGROUND

4.2.1. Verbalization

Group debate about reasons for and against a strategic option requires verbalization of reasons. The effect of verbalization is the focus of a number of distinct strands of cognitive psychology literature. To a large extent these strands in cognitive psychology have been developed in isolation of each other and their results are seemingly contradictory. We review these here.

The activation effect of verbalization

A stream of research has found that verbalization of reasons has a positive effect on the ability to solve complex problems, specifically 'Tower of Hanoi' problems. In such a problem, a set of discs needs to be moved from one circle to another of three circles in a number of moves and under certain move restrictions. Such studies have found that those individuals who are asked to verbalize reasons prior to each move need fewer moves to solve the problem than those not verbalizing reasons (Ahlum-Heath & Di Vesta, 1986; Bartl, 2000; Bartl & Dorner, 1998; Berardicoletta, Dominowski, Buyer, & Rellinger, 1995; Berteau, 1999; Davies, 2000; Dickson, McLennan, & Omodei, 2000; Gagne & Smith, 1962; Hacker & Wetzstein, 2004; Hussy, 1987; Stinessen, 1985).

Similar results were found with a different task by Berry and Broadbent (1984). In an experiment, participants repeatedly made staffing decisions for sugar plants in an attempt to manage the amount of sugar production. After having received verbal instruction informing participants of how staffing decisions influenced sugar production, those that verbalized reasons prior to

each staffing decision did much better at achieving the desired level of sugar production than those not verbalizing reasons. Explanations for the effect of verbalizing reasons include that individuals are stimulated to 'stop and think' (Gagne et al., 1962), and to keep attention focused on critical features of the decision (Berry et al., 1984). More generally, verbalizing reasons has an activating effect: *it brings into consideration reasons that may not have been fully considered otherwise.*

Another example of how verbalization has consequences due to the activating effect of verbalization is provided by the literature on self-explanations. In one study, Chi, de Leeuw, Chiu and LaVancher (1994) found that eighth grade students reading a passage on the human circulatory system and explaining out loud each sentence to themselves after reading it had greater pretest-posttest gains in understanding and recall after 1 week than students who instead of self-explaining read each sentence a second time. Similarly, they found that students who explained to themselves aloud a set of worked out examples of applications of Newton's laws developed a better understanding of cause-effect relationships covered by these laws than students who did not (Chi, Bassok, Lewis, Reimann, & Glaser, 1989). The verbalizing of reasons (explanations) out loud had an activating effect, which enhanced recall.

Another example of the activating effect of verbalization is the articulatory loop. Baddeley found that when individuals orally verbalize, their (short term) *working memory* is enhanced, e.g. those stating a phone number out loud remember it better shortly thereafter than those who try to memorize the number without orally verbalizing it. This is called the articulatory loop, in which information is temporarily held (Baddeley, 1999). Verbalizing activates the verbalized information and this affects short term recall.

The overshadowing effect of verbalization

There is another extensive stream of research, led by Schooler and colleagues (Fiore et al., 2002; Schooler, 2002; Schooler et al., 1993; Wilson et al., 1993; Wilson et al., 1991), that finds that in certain conditions verbalization has negative effects on cognitive performance. This negative effect is the result of 'verbal overshadowing', i.e. a bias towards more easily verbalizable thoughts. For example, non-expert individuals who are asked to decide which jams they consider highest quality and who verbalize the reasons prior to giving the ratings deviate more from expert ratings than individuals who rate without verbalizing reasons (Wilson et al., 1991). Another example is that when witnesses of a crime provide a verbal description of the perpetrator they make fewer correct identifications of the perpetrator from photospreads, compared with witnesses who do not verbalize (Schooler & Engstler-Schooler, 1990). A last example is the selection of college courses: students were provided with information about college courses in the upcoming period and those who verbalized the reasons for how they felt about each course were less likely in that next course period to enrol in courses that were rated highly by students who had already taken the course (Wilson et al., 1991). Logically, bias in decision-making due to verbal overshadowing can only occur when, first, there is variance in the ease of verbalization of reasons, i.e. when some knowledge is more easily verbalizable than other knowledge, *and*, second, when the less easily verbalizable reasons and the more easily verbalizable reasons have contrary implications for which decision is to be taken. This seems to be the case in the context of radical and incremental innovations, as we will discuss further in our theory and hypotheses section.

4.2.2. Group debate

Laughlin and colleagues (2006; 2003) found that debate by a group of individuals leads to better performance than the best individual could have achieved alone, on intellective tasks where there is a demonstrably correct answer. Laughlin and colleagues explained that on these intellective tasks team members in group debate each offered ideas towards the solution and that teams, given the demonstrability of the solution, could evaluate the merits of each idea. By taking the best ideas of each team member the group was able to achieve a higher performance than any of the individuals could have reached. This is in an interesting finding, and it begs the question what the effect is of group debate when there is no demonstrably correct solution, and hence the team cannot easily evaluate the merits of each individual contribution, as is the case in making a strategic choice to pursue a specific innovation.

4.2.3. Ability to modify self presentation

A group setting is a social setting and in group debate individuals need to consciously be sensitive to expressive behavior of others, e.g. in response to the individual's statements, and need to continuously adapt their self-presentation given the responses of others. Such monitoring and adapting self-presentation pose a cognitive load. Work by Snyder and colleagues (Snyder, 1974; Snyder & Gangestad, 1986) has shown that in social settings individuals chronically differ in their ability to modify their self-presentation (Lennox & Wolfe, 1984). Whereas some individuals have strong ability to modify their self-presentation, other individuals have greater difficulty modifying self-presentation. For individuals with high ability, the cognitive load from having to adapt one's self-presentation is lower than for individuals

with low ability (Chapter 2). The ability to modify self-presentation, is theoretically and empirically a distinct component of self-monitoring, e.g. distinct from the sensitivity to expression of others (see e.g., Briggs & Cheek, 1988; Gabrenya & Arkin, 1980; Miller & Thayer, 1989).

Self-presentation can be either verbal or nonverbal or a combination thereof (Snyder, 1974). Underlying the ability to modify self-presentation is the ability to effectively present one's own thoughts and feelings in group discussion, be it verbally or nonverbally (Lennox et al., 1984; Snyder, 1974). This is a relevant personality trait in the context of verbalization: when in group discussion certain thoughts and feelings are difficult to present verbally, the ability to effectively express such thoughts and feelings may play an important role.

4.3. THEORY AND HYPOTHESES

As discussed above, when reasons are verbalized what is verbalized depends on the ease of verbalization: reasons that are more difficult to verbalize are less likely to be verbalized than reasons that are easier to verbalize (overshadowing effect). In addition, whatever is verbalized is made more salient (activating effect). Hence, when the reasons in favor of a decision option A are relatively difficult to verbalize, and the reasons in favor of another decision option B are relatively easy to verbalize, we expect that verbalization will make the reasons in favor of option B more salient than those for option A. This seems relevant in the context of innovation: we focus on the decision to advance a radical innovation, i.e. an innovation that is based on a new set of engineering and scientific principles and often opens up whole new markets and potential applications (Henderson et al., 1990), or an incremental innovation, i.e. an innovation that introduces relatively minor changes to the existing product, to the market launch stage. The reasons why a radical innovation may be useful are relatively difficult to verbalize: not much is known about future buyers, competitors, prices, costs and hence profitability (Christensen et al., 1996). The reasons why an incremental innovation is useful are, in comparison, relatively easy to verbalize: buyers, competitors, prices, costs and hence profitability are more concretely understood. For example, when Sony first launched the Walkman, it was clearly new, but it was difficult to verbalize the reasons why this innovation was useful. It was difficult to be explicit about how the Walkman would be useful to consumers and to Sony (e.g. in terms of sales, profitability, reputation, etc). In contrast, when Sony later launched new versions of the Walkman, incremental innovations, it could verbalize much more lucidly why these innovations were useful to typical Walkman users and to Sony. Given this difference in how easily reasons in favor of an incremental vs. a

radical innovation are verbalized, and given that easily verbalized reasons gain more salience as opposed to less easily verbalized reasons (as verbal overshadowing studies at the individual level of analysis have suggested), we predict that group debate about an incremental vs. radical innovation will lead to a bias towards deciding in favor of the incremental innovation: the reasons in support of the incremental innovation are easily verbalized and are made more salient by the verbalization, whereas those in support of the radical innovation are not so easily verbalized and thus do not become similarly salient. Because reasons that are easily verbalized are more likely to be discussed in group debate than reasons that are relatively difficult to verbalize and because reasons in favor of a radical innovation are more difficult to verbalize than reasons in favor of an incremental innovation and are more difficult to verbalize than reasons against a radical innovation, group debate will reduce the likelihood of the group deciding in favor of a radical innovation.

> *H1. At the group level of analysis, group debate about a decision to invest in an incremental or radical innovation will lead to a bias towards the incremental innovation option, in comparison with making the decision without prior group debate.*

A group setting is a social setting and in group debate individuals need to continuously monitor the expressive behavior of others and to adapt one's self-presentation accordingly. Especially when an individual's ability to modify self-presentation is low, the need to monitor and adapt one's self presentation accordingly provides a substantial cognitive load, leaving less cognitive capacity available for other tasks (Chapter 2). In addition, underlying the ability to modify self-presentation is the ability to effectively present one's own thoughts and feelings in group discussion, be it verbally or nonverbally

(Lennox et al., 1984; Snyder, 1974). Combining these points we suggest that individuals with low ability to modify self-presentation, have relatively *little cognitive capacity* available for expressing reasons in favor of an innovation (because the social setting demands a cognitive load), and have a *relatively low ability* to express difficult to verbalize reasons, which makes it relatively unlikely that they will express reasons in favor of a radical innovation well, given that in particular reasons in favor of a radical innovation are difficult to express, compared to reasons in favor of an incremental innovation option. Expressing reasons in favour of an incremental innovation option is relatively easy and requires little cognitive capacity, and hence is less challenging for those with low ability to modify self presentation than expressing reasons in favor of a radical innovation.

When groups start a discussion about two decision options such as adopting an incremental or a radical innovation, there is some variance in the initial opinions (Isenberg, 1986), i.e. some individuals have an initial opinion in favor of the incremental option, others in favor of the radical innovation option. When a group engages in debate, individuals express their thoughts supporting their initially preferred decision option and are critized by others (Simons et al., 1999). When average ability to modify self-presentation is low, those initially in favor of the radical innovation option do not have the capacity and ability to express the reasons in favor of the radical innovation well and the debate in the group will center on the reasons in favor of the incremental innovation, as these are easy to express and hence require little capacity and ability to express. In such a setting, it is unlikely that those initially in favor of the initial innovation would change their preference, whereas those initially in favor of the radical innovation are likely to change their preference due to the emphasis of the group debate on the incremental innovation, and their inability to express appropriately the reasons for the

radical innovation, as a result of which the preference for the radical innovation becomes less tenable. When a few team members shift their opinion from radical to incremental innovation, it becomes more likely that the group will decide in favor of the incremental innovation. In sum, we expect that especially if ability to modify self-presentation is low, verbal overshadowing will occur and debate will lead to a shift towards incremental innovations.

When average ability to modify self-presentation is high in a team, the individuals need relatively little cognitive capacity for monitoring and adapting accordingly to the social setting and have high ability to express thoughts and feelings. When groups engage in debate about innovations and average ability to modify self-presentation is high, the members with an initial opinion in favor of a radical innovation are likely to effectively express the reasons in favor of the radical innovation, that tend to be difficult to express. This leads to greater salience of these reasons than without debate, and may sway some of those with an initial opinion in favor of an incremental innovation towards the radical innovation. As a result, when average ability to modify self-presentation is high, debate increases the likelihood that teams choose a radical innovation. In this case, it is not verbal overshadowing of the reasons for the radical innovation by the reasons for the incremental innovation, but increased verbal activation of the reasons in favor of the radical innovation that explains the effect of debate on the type of innovation chosen.

H2. At the group level of analysis, the effect of group debate on the innovation decision (incremental vs. radical) taken is affected by the average ability to modify self-presentation; when average ability to modify self presentation is low, group debate will shift the decision towards the incremental innovation (verbal overshadowing), when average ability is high, group debate will shift the decision towards the radical option (verbal activation).

4.4. METHOD

4.4.1. Design

We conducted a randomized experiment in which real teams were given information about two product proposals: one incremental innovation (a storage capacity extension for a USB stick) and one radical innovation (a USB stick not requiring plugging-in, i.e. wireless). The conditions were: I. Group decision-making without debate (immediate anonymous voting), II. Group decision making with prior group debate. To test hypothesis 1 and 2, we first aggregated the decisions of individuals in the no-debate condition to group decisions: we counted the decisions by individual team members in favor of the incremental and those in favor of the radical innovation and determined the group decision based on whichever decision received the majority based on the individual decisions (there were no ties). We then compared these group decisions with the decisions made by the teams in the group debate condition, who differed only in that they had group debate prior to taking the decision as a team.

We used a randomized experiment rather than observations or a survey, because 1) when manipulation of conditions and randomisation are possible, experiments offer compelling advantages in terms of internal validity (inferences regarding causality), and because 2) we wanted to keep the decision options and information provided constant in order to enhance statistical validity (Aronson et al., 1998; Cook et al., 1979).

4.4.2. Sample

The sample consisted of 39 real teams of 4-5 students formed during a 12-week business simulation course, with 178 last-year bachelor students in total who took part for course credit. These students were knowledgeable about USB sticks, and hence had the knowledge required to perform the experimental task. The experiment took place after the teams had two months of experience working together as a team; as a result the teams are real teams, not ad-hoc created teams, which serves to enhance the external validity of our findings. Teams were randomly allocated to the two: 19 teams (86 individuals) to condition I, 20 teams (92 individuals) to condition II.

4.4.3. Procedure

In the first week of the business simulation course, all participants completed a short survey to capture informational diversity and ability to modify self-presentation. Roughly 2 months later, participants took part in the experiment one team at a time. The experimenter handed out a sheet of information that explained that the R&D department of the (in actuality fictitious) company Memory International (in the competitive business of producing and selling USB sticks) had come up with two new product proposals. One proposal was a new design memory stick that was wireless but had only half the storage capacity of existing USB sticks. This is a radical innovation (although not identified as such to participants), in accordance with the definition of radical innovation quoted from Henderson and Clark (1990), given that it would require a new set of engineering and scientific principles (e.g. new product components are included such as a wireless connection device, whereas others can be removed, e.g. a USB connection and the cap, the architecture of the stick can also change, i.e. it does not need to be a

"stick", and finally it also opens up new potential applications and markets, e.g. ability to easily allow people at meetings to easily access key files on other's USB sticks, etc. etc.). Another proposal was a significant expansion of the storage capacity of the existing USB sticks. This was the incremental innovation option (although not identified as such to participants), given that the product changes are relatively minor: no new types of components, no change to the design, no changes in applications and markets foreseeable. In addition, background information was provided:

> "Product developers think that no longer having to plug in a memory stick has many possible applications, but they cannot yet articulate which ones. Also computer experts think that this product feature has a lot of potential. In market research, 80% of customers say that increasing memory capacity is the most important improvement in USB sticks that they desire. They say that memory capacity is the most important factor in the decision for buying a specific brand USB stick."

The concrete reasons suggesting that the *incremental* innovation is useful were easy to verbalize (as they were clearly specified), whereas the reasons suggesting that the *radical* innovation is useful were less easy to verbalize (unclear which customers are interested, for which applications etc). This is a very typical and realistic situation: knowledge about the benefits and downsides of an incremental innovation and about the downsides of a radical innovation is usually high and hence such benefits and downsides are easy to verbalize, whereas knowledge about the benefits of a radical innovation is more limited upfront, and hence more difficult to verbalize ex-ante. Not only is this setting highly typical for innovation, it is also a very similar setting to the case of jams and college courses used in previous studies of verbal

overshadowing (Wilson et al., 1991): e.g. in the jam case some reasons were easy to verbalize (such as the number of strawberry chunks in the jam) and others were more difficult to verbalize (such as characteristics of the texture of the jam).

In condition I (no debate) team members were then asked to make a decision for one of the two options individually, i.e. without discussing with other team members. In condition II (group debate), teams were asked to debate the reasons for each decision option during 10 minutes. After 10 minutes of discussion, the groups in this condition were asked to make and record a decision for either the incremental or radical innovation. Thereafter students were debriefed, thanked and dismissed.

4.4.4. Analysis

We tested hypothesis 1 and 2 with probit and logit regression of the innovation option chosen on the condition, including controls for the level of informational diversity because there is a stream of literature that argues that in the context of debate diversity leads to more innovative decisions (Bantel & Jackson, 1989; Barkema & Chvyrkov, 2007; Boeker, 1997; Wiersema & Bantel, 1992). To control for this we include a variable capturing the level of informational diversity and an interaction term of the condition (debate/no debate) and the level of informational diversity (because diversity is likely to only have an impact on the innovation decision in the condition of debate, and not in the condition of no debate).

4.4.5. Measures

Ability to modify self presentation was measured using the Lennox & Wolfe (1984) 13-item Revised Self-Monitoring scale, more specifically its Dutch version, as first used in an empirical study by De Vet and De Dreu (Chapter 2). This Dutch version was developed by Steinel and has good psychometric qualities (Steinel, 2004). Examples of items in the scale are (a) I have the ability to control the way I come across to people, depending on the impression I wish to give them; (b) When I feel that the image I am portraying isn't working, I can readily change to something that does; and (c) Once I know what the situation calls for, it's easy for me to regulate my actions accordingly. Principal Component Analysis with Varimax Rotation showed that the 13 items loaded on two factors as expected, and within scales ratings for the first factor were averaged into an index for "self-monitoring ability" (the second factor reflected "sensitivity to expression of others"). Cronbach alpha was 0.7.

Informational diversity was proxied by educational diversity, which we measured by asking participants to indicate the electives they have taken during their studies. These electives were part of accounting, finance, marketing or organization study tracks. Students tend to take many electives in one track, and some outside this focus. We counted the number of electives in each track taken by each student and identified the primary study focus of each student by identifying the track in which the most electives had been taken. As is common practice when a diversity measure is based on categorical data, we then estimated the informational diversity of the group by calculating a Blau's index (Blau, 1977) based on the number of team members in each focus area (accounting, marketing, finance, organization).

4.5. RESULTS

To test hypothesis 1, we compared the choices made by the teams in condition I (no group debate) and those made by teams in condition II (group debate). We ran probit and logit regressions of the choice made by the team on the debate condition. Results were opposite to our hypothesis, i.e. groups debating were more likely to adopt the radical innovation (as opposed to the incremental innovation) than groups not debating: t-statistic −2.08 and −1.98 for probit and logit regressions respectively (two-tailed $p<0.04$ and $p<0.05$ respectively, $n=39$). The share of teams adopting the radical innovation option was 11% in the no-debate condition, and 40% in the debate condition.

However, because there is a literature suggesting that task-relevant diversity in teams may lead to more innovation (see earlier), we felt we had to control for diversity. So, we ran probit and logit regressions of the innovation choice made on the debate condition, the level of informational diversity (measured as diversity in educational focus), and an interaction for diversity and debate to control for the effect of diversity on innovation in the debate condition. We did not centralize diversity in the interaction term (Aiken et al., 1991), because we wanted the coefficient for the main effect of debate to reflect the effect of debate in the case of no diversity (and we did have teams with no diversity in the sample), so that we could make strong claims that any effect that we found for debate could not be attributable to the fact that (even at lower levels of diversity) diversity has been found to lead to innovation.

After thus controlling for informational diversity, the effect of group debate was no longer significant. See table 4.1 for descriptives and table 4.2 for results of the probit regression. Logit results were similar.

Table 4.1

Descriptives and zero-order correlations (n=39)

	M	SD	1	2	3	4
Innovation decision	0.74	0.44	1			
Group debate	0.51	0.51	–.34**	1		
Diversity	0.43	0.21	0.08	–0.05	1	
Ability to modify	24.59	1.26	–0.16	–0.06	–0.08	1

** two-tailed $p<0.05$

Table 4.2

Results group-level probit regression (n=39)

	B	SE	T
Intercept	0.85	0.68	1.24
Debate (yes/no)	–0.29	1.03	–0.28
Diversity	1.00	1.45	0.69
Diversity*Debate	–1.73	2.21	–0.78

Dependent: innovation decision (0: radical, 1: incremental)

To test hypothesis 2, we ran probit and logit regressions of the choice made on the condition (group debate/no group debate), the average ability to modify self-presentation of team members and an interaction for ability to modify self-presentation and debate. We also included as independents the level of informational diversity and an interaction for diversity and debate, to control for the effect of diversity on innovation in the debate condition. Following the suggestion of Aiken and West (Aiken et al., 1991) we centralized ability to modify self presentation in the interaction term. This was appropriate as we were interested in understanding the main

effect of debate at the average level of ability to modify self presentation and because not centralizing would indicate the main effect of debate at zero ability to modify self presentation. Because we did not actually have any teams with zero ability to modify self-presentation in the sample, and because there is no prior literature suggesting that there is a main effect of ability to modify self presentation on innovation in debate, we did centralize. However, we did not do so for informational diversity in its interaction with debate, with good reason, as explained above.

We found, as predicted, that the interaction of the average ability to modify self presentation and debate was significant, in the direction predicted (probit $t = -1.76$, $p<0.08$ two-sided, $p<0.04$ one-sided; logit $t = -1.61$, $p<0.10$ two-sided, $p<0.05$ one-sided). It is surprising to find these levels of significance for an interaction term with such a small sample size ($n=39$ in this comparison). The coefficients of debate, diversity, the interaction of diversity with debate, or the ability to modify self presentation were not significant.

Table 4.3

Results group-level probit regression (n=39)

	B	SE	T
Intercept	–5.50	9.36	–0.59
Debate	–0.05	1.17	–0.05
Diversity	1.47	1.71	0.86
Diversity*Debate.	–2.59	2.61	–0.99
Ability to modify	0.25	0.37	0.68
Ability* Debate.	–0.85	0.48	–1.76**

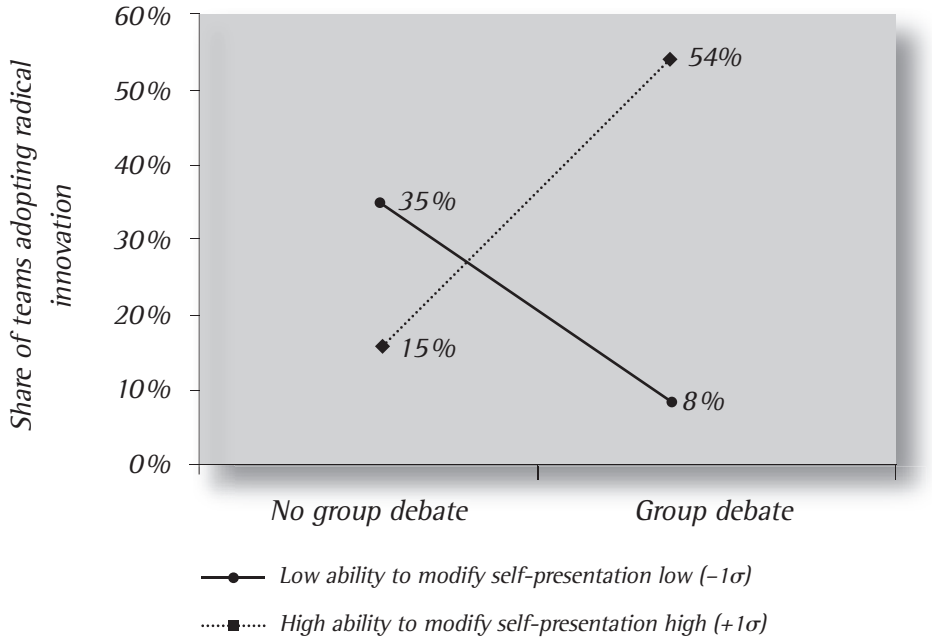
** $p<0.05$ one-sided

Dependent: innovation decision (0: radical, 1: incremental).

The interpretation of the interaction term is as predicted: the higher the average ability to modify self-presentation of a team the more positive the impact of debate is on the likelihood of choosing the radical innovation. For teams with relatively low ability to modify self-presentation (one standard deviation below the mean), group debate leads to verbal overshadowing and teams are less likely to choose the radical innovation (8% probability of choosing the radical innovation) than had they not engaged in debate (35%). For teams with relatively high ability to modify self-presentation, debate leads to verbal activation and the likelihood of adopting the radical innovation is higher with debate (54%) than without debate (15%); all these reported probabilities are calculated at zero diversity, because we want to completely abstract from known effects of diversity on innovation. See figure 4.1. This pattern of findings supports our hypothesis 2.

Figure 4.1

Interaction Group debate – Ability to modify self-presentation (at zero diversity)



4.6. CONCLUSIONS AND DISCUSSION

We have used the cognitive psychology literature on verbalization and the social psychology literature on ability to modify self-presentation to shed light on a debate in the management literature about the effects of group debate on strategic decision-making about innovation, in particular decisions to adopt incremental vs. radical innovations.

We argued that debate about reasons for an innovation can lead to verbal overshadowing, but that this may only occur when the average level of ability to modify self-presentation is low, and that when it is high, not verbal overshadowing but verbal activation may prevail. When ability is low, team members initially in favor of a radical innovation do not have the capacity or ability to express the reasons in favor of the radical innovation, whereas those in favor of an incremental innovation do, driven by the phenomenon that reasons in favor of an incremental innovation require little capacity or ability to express. When ability is high, team members initially in favor of a radical innovation do have the capacity and ability to express reasons in favor of the radical innovation and their doing so makes these reasons more cognitively accessible, more salient, more activated, which may sway some of those initially in favor of the incremental innovation towards supporting the radical option.

We find no main effect of group debate on innovation, but do find support for the idea that for teams with relatively low ability to modify self-presentation (e.g. one standard deviation below the mean), group debate leads to verbal overshadowing and hence the likelihood to choose a radical innovation is relatively low (8%) compared with teams who do engage in debate (35%). However, for teams with relatively high ability to modify self-presentation, group debate does seem to lead to verbal activation: the likelihood to adopt the radical innovation is 15% without debate, and 54% with debate.

We have enriched the literature about group debate and strategic decision-making, in particular by focusing on the effects of group debate on strategic decision-making about innovation, i.e. the effect of group debate on strategic innovation decisions. We have combined cognitive psychology literature (on verbalization overshadowing and verbal activation) and social psychology

literature (on ability to modify self-presentation) to predict when debate leads to decision shifts towards a radical innovation and when to shifts towards an incremental innovation.

Our findings are also valuable for practitioners. Our study suggests that when an organization creates a team that needs to make decisions about which innovation ideas to pursue (e.g. a steering committee taking decisions in the context of innovation pipeline management, or a research or NPD team, that in the course of its work decides to pursue certain innovation ideas and abandon others), management should pay attention, when selecting people for the team, to the ability of individuals to modify their self presentation. When the objective is to stimulate radical innovation, high ability is desired, when the objective is to stimulate incremental innovations, low ability to modify self-presentation is desired (assuming that these teams engage in debate before taking decisions). Alternatively, the team should be asked to make decisions without group debate preceding the decision, if a team is high on ability but incremental innovations are preferred by senior management or if a team is low in ability to modify self presentation but radical innovations are preferred by senior management.

Future research could test our theory in a business setting, and could for example extend our theory by studying the effect of the amount of time elapsed between debate (e.g.. about pros and cons for each decision option) and the moment the decision is taken. It may be that increases in the length of such a time intermezzo between debate and the decision reduces the effects of verbal overshadowing (when ability to modify self presentation is low), whereas the effects of verbal activation (when ability to modify self presentation is high) of reasons in favor of a radical innovation are not reduced by time. Studying the effect of the amount of time elapsed

between debate and the moment the decision is taken is especially relevant in a realistic, business setting, as in practice there is a natural succession of group and individual work, which can hardly be prevented. Hence, to make the findings directly applicable we need to study not whether debate took place (it will always have), but whether debate took place in a certain time period before the decision.

To strengthen the findings, it would also be worthwhile in a next study to test directly the assumption that individuals with high ability to modify self-presentation have relatively little difficulty expressing difficult to verbalize thoughts and feelings, and it would be desirable to have a larger sample so that the significance of the two slope coefficients constituting the interaction of debate and ability to modify self-presentation can be tested. Finally, it would be more realistic if in condition 1 (no group debate) the team itself comes to a decision without group debate (e.g. by voting with show of hands, or anonymous voting), rather than that the experimenters determine the group decision in this condition by counting the votes of team members and implying a group decision from the majority vote.

CHAPTER 5
SUMMARY AND CONCLUSIONS

It is generally acknowledged that in order to sustain and enhance performance, firms need innovation. Innovation allows companies to grow, to win in the competitive race, and to make high profits, and it allows societies composed of innovating companies to enjoy high employment levels, high wages, and high standards of living.

There is a substantial amount of research on innovation. First, of all there is a lot of research at the firm level of analysis, e.g. regarding patterns in R&D expenditures, threats of innovation to incumbents, exploration vs exploitation, market orientation, and alliances of a firm.

However, not only the firm level of analysis can shed light on factors that affect firm innovation. Innovation by firms is a product of individuals and teams working together. Innovation is essentially a product of useful new ideas. Such ideas are first generated by an individual or a team and are then adopted and institutionalized by the firm (Crossan et al., 1999). Innovation performance by a firm is hence clearly dependent on generation of useful novel ideas (creativity) and the selection of useful novel ideas (decision-making) by individuals and teams. This dissertation focused on exactly that: the generation and selection of useful novel ideas by individuals and teams.

In terms of the factors that affect creativity and decision-making in the context of innovation, I focused on thinking in silence, as opposed to thinking aloud at the individual level of analysis, and as opposed to group debate at the group level of analysis.

There is a number of streams of literature on the effects of thinking in silence on cognitive performance (see chapters 2, 3, and 4 for reviews). Some streams suggest these effects are positive (e.g. verbal overshadowing, production blocking), some suggest these are negative (e.g. verbal activation). The literature on the effects of thinking in silence on innovation is filled with important gaps which I have defined precisely in chapters 2-4.

In chapter 2, we found that the effect of thinking in silence on individual creativity depends on self-monitoring characteristics of the individual. When the ability to modify self presentation is low *and* the sensitivity to expressive behaviour of others is high, thinking in silence has a notably positive impact on individual creativity, in comparison with thinking aloud. Otherwise, there is no impact on individual creativity. Or in other words, when thinking aloud (but not when thinking in silence), sensitivity to the expression of others only negatively affects creative ideation when ability to modify self-presentation is low. This finding is important because it suggests that constructs such as sensitivity to others, social anxiousness and evaluation apprehension impact creative ideation especially when people have difficulty adapting, and not when people easily adapt to others. This is an important contribution to the literature so far, that did not distinguish between the effects of these two parts of self-monitoring (sensitivity to others and ability to adapt) on creative ideation.

In chapter 3, I took the study of the effect of thinking in silence on idea generation to the group level of analysis, and hence focused on the effect on creativity (which is an important input for innovation) of thinking in silence versus group debate. The underlying assumption in reviewed management literature is that group debate is more effective for innovation than individuals thinking alone. I challenge that belief: I found in chapter 3 that *suspending*

group debate (temporarily) can be productive for innovation, when at least one group member has relatively low extraversion. Holding a (5 minute) intermezzo for thinking alone, following a phase of initial group debate to share information and perspectives on the problem under discussion, and followed by further group debate, has a major positive effect on the number of ideas generated by a group (without negatively affecting quality of the ideas), unless all members of the group are relatively extraverted. The moderating effect of extraversion is understandable: individuals who are relatively introverted are relatively less able to multitask (Lieberman et al., 2001). Group problem-solving does require multitasking: listening to the ideas of others, monitoring the discussion to determine when to speak up, remembering own ideas generated, and generating new ideas. Those who are less able to multitask (the introverts), benefit a lot from a temporary relief from all those demands on cognitive capacity, and this explains why an intermezzo for thinking in silence helps especially when one or more team members is relatively introverted.

The managerial implications are clear and can easily be put into practice: use a short (e.g. 5 minute) intermezzo for thinking in silence during group problem-solving meetings, especially if there is a need to generate more ideas and if at least one of the team members is relatively introverted.

In chapter 4, I shifted the focus from generation of ideas to selection of ideas, at the group level of analysis. I focused on strategic decisions, i.e. decisions to adopt incremental or more radical innovations for market launch. Although group debate and strategic decision-making have both been extensively studied in the literature, there has been a lack of research on the effect of group debate on strategic decision-making in the context of innovation. In chapter 4, I started filling this gap with a study on the effect

of group debate vs. thinking in silence on the *type* of innovation selected (in casu, radical versus incremental innovation). I found that this effect depends on group members' average ability to modify self presentation. When ability to modify self-presentation is high, group debate leads to more decisions in favor of a radical innovation as compared with no group debate (individuals think and decide in silence and group decision is based on majority vote). When ability to modify self-presentation is low, group debate leads to more decisions in favor of an incremental innovation as compared with no group debate. We predict and explain this finding relying on distinct streams of literature on verbal overshadowing and on verbal activation, that have till now not been combined in one study.

When average ability to modify self-presentation is low, those initially in favor of the radical innovation option do not have the capacity and ability to express the reasons in favor of the radical innovation well and the debate in the group will center on the reasons in favor of the incremental innovation, as these are easy to express and hence require little capacity and ability to express. In such a setting, it is unlikely that those initially in favor of the incremental innovation would change their preference, whereas those initially in favor of the radical innovation are likely to change their preference due to the emphasis of the group debate on the incremental innovation, and their inability to express appropriately the reasons for the radical innovation, as a result of which the preference for the radical innovation becomes less tenable. When a few team members shift their opinion from radical to incremental innovation, it becomes more likely that the group will decide in favor of the incremental innovation. In sum, we expect that especially if ability to modify self-presentation is low, verbal overshadowing will occur and debate will lead to a shift towards incremental innovations.

When average ability to modify self-presentation is high in a team, the individuals need relatively little cognitive capacity for monitoring and adapting accordingly to the social setting and have high ability to express thoughts and feelings. When groups engage in debate about innovations and average ability to modify self-presentation is high, the members with an initial opinion in favor of a radical innovation are likely to effectively express the reasons in favor of the radical innovation, that tend to be difficult to express. This leads to greater salience of these reasons than without debate, and may sway some of those with an initial opinion in favor of an incremental innovation towards the radical innovation. As a result, when average ability to modify self-presentation is high, debate increases the likelihood that teams choose a radical innovation. In this case, it is not verbal overshadowing of the reasons for the radical innovation by the reasons for the incremental innovation, but increased verbal activation of the reasons in favor of the radical innovation that explains the effect of debate on the type of innovation chosen

Summing up all these studies, I suggest that, under certain conditions, thinking in silence can positively affect individual and group creativity and can affect the types of innovation ideas selected by a decision-making group.

Many interesting questions for future research remain. First it would be interesting to study whether the effect of the interaction of ability to modify self presentation and sensitivity to expressive behaviour of others on creativity, that we found in chapter 2 at the individual level of analysis, can also be found at the group level of analysis and whether the effect depends on the size of the group given that the size of the group increases the need to process information expressed by others which is more relevant for those high in sensitivity to expressive behaviour of others.

Second, regarding chapter 3, it would be interesting to study the effect of the *length* of the intermezzo for thinking in silence during group debate on group creativity and to study the effect of the *starting time* of the intermezzo (e.g. at the very beginning, shortly after the start, at the midpoint, close to the end) on group creativity. More generally it would be valuable to study the effect of an intermezzo in a different setting, e.g. with teams of managers in organizations.

Third, it would be interesting to study whether the effect of extraversion on the effect of the intermezzo on team creativity is linear. This would require a larger sample than in our study.

Fourth, it would be interesting to investigate whether an intermezzo for thinking alone during group debate (chapter 3) affects decision-making by the group as much as completely thinking in silence does (as investigated in chapter 4).

Finally, chapter 4 could also be repeated but now at the individual level instead of the group level of analysis. In other words does thinking in silence affects the type of innovation adopted, at the individual level of analysis?

SAMENVATTING (SUMMARY IN DUTCH)

Het wordt algemeen erkend dat innovatie van doorslaggevend belang is voor het verbeteren van de resultaten van een onderneming. Het verbaast derhalve ook niet dat er op het gebied van innovatie een grote hoeveelheid wetenschappelijk onderzoek plaats vindt. Er is veel onderzoek op het analyse niveau van een organisatie, bijvoorbeeld met betrekking tot patronen in R&D investeringen, de bedreigingen die van bepaalde vormen van innovatie uitgaan jegens gevestigde ondernemingen, exploratie versus exploitatie, de (soms ongewenste) effecten van markt oriëntatie, en allerlei aspecten van alliantievorming door een firma.

Echter, ook het niveau van het individu of de groep is interessant voor wetenschappelijk onderzoek naar innovatie. Tenslotte is innovatie het product van nieuwe nuttige ideeën. Zulke ideeën worden initieel gegenereerd door een individu of team en worden vervolgens geadopteerd en geïnstitutionaliseerd in een organisatie (Crossan et al., 1999). De innovatie prestatie van een onderneming is dus duidelijk afhankelijk van de ontwikkeling van nieuwe nuttige ideeën en de selectie van de beste daarvan, door individuen en teams. Deze dissertatie richt zich precies daarop: de ontwikkeling en selectie van nieuwe nuttige ideeën door individuen en teams.

Wat betreft de antecedenten, d.w.z. de factoren die de ontwikkeling en selectie van nieuwe nuttige ideeën beinvloeden, richt ik me op stilzwijgend denken, in vergelijking met hardop denken (op het niveau van het individu) en in vergelijking met debat (op het niveau van de groep).

Er is een aantal stromingen in de literatuur over de effecten van stilzwijgend denken op cognitieve prestatie (zie hoofdstukken 2, 3, en 4 voor een

bespreking van deze stromingen). Sommige studies suggereren dat deze effecten positief zijn, andere dat ze negatief zijn. In de hoofdstukken 2, 3, en 4 lever ik een bijdrage aan deze discussie.

In de studie beschreven in hoofdstuk 2 suggereren we dat het effect van stilzwijgend denken op individuele creativiteit afhangt van bepaalde individuele kenmerken op het gebied van ‚self-monitoring'. Stilzwijgend denken heeft in vergelijking met hardop denken een sterk positief effect of individuele creativiteit, als iemand niet goed in staat is om zijn eigen presentatie jegens anderen aan te passen *en* relatief gevoelig is voor uitdrukkingen van anderen. Dit is een belangrijke bijdrage aan de literatuur, die tot nu toe geen rekening hield met de distinctie en de interactie tussen deze twee eigenschappen in hun effect op creativiteit.

In de studie beschreven in hoofdstuk 3, bestudeer ik dezelfde causale relatie als in hoofdstuk 2, maar nu niet op het niveau van het individu, maar dat van de groep. De vraag is wat het effect is van het houden van een kort intermezzo voor stilzwijgend denken tijdens een vergadering, op de creativiteit van de groep. De veronderstelling van de meeste management literatuur en van managers zelf is dat groepsdiscussie beter is voor innovatie dan individueel denken. Ik ontwikkel in dit proefschrift theorie om uit te leggen waarom dat een misleidende veronderstelling is. Ik beredeneer en vind in deze studie empirische ondersteuning voor de stelling dat het tijdelijk stoppen van de groepsdiscussie een positief effect heeft op de creativiteit van de groep, indien minimaal een lid van de groep relatief introvert is. Introverte individuen zijn relatief slecht in staat om meerdere dingen tegelijk te doen (multi-tasken) (Lieberman et al., 2001). Multi-tasken is in groepsdiscussies nodig: deelnemers moeten tegelijkertijd luisteren naar anderen, zelf ideeën ontwikkelen, de bedachte ideeën onthouden en in de gaten houden wanneer

zich een gelegenheid voordoet om deze ideeën met de groep te delen. Dit multi-tasken is moelijk voor introverte individuen en daarom profiteren met name zij van een intermezzo voor stilzwijgend denken waarin ze ongestoord ideeën kunnen ontwikkelen. Derhalve levert een intermezzo voor stilzwijgend denken een bijdrage aan de creativiteit van de groep, indien er minimaal een persoon relatief introvert is.

De implicaties voor teams zijn duidelijk en gemakkelijk in de praktijk te brengen : zet gedurende een groepsdiscussie het gesprek na een tijd stop voor een intermezzo voor stilzwijgend denken (bijvoorbeeld 5 minuten), en pak direct daarna de draad weer op. Zolang de groep niet louter uit relatief extroverte individuen bestaat, verhoogt dit de creativiteit van de groep.

In de studie in hoofdstuk 4, verschuif ik de focus van idee ontwikkeling naar idee selectie, op het niveau van de groep. Ik bestudeer het effect van stilzwijgend denken (in vergelijking met groepsdebat) op beslissingen, i.c. strategische beslissingen: de adoptie van een incrementele of radicale innovatie voor introductie op de markt. Groepsdebat en strategische besluitvorming zijn beide al veel door wetenschappers bestudeerd, maar niet het effect van eerstgenoemde op laatstgenoemde, in de context van innovatie. Ik beredeneer, en vind voor deze redenering in deze studie ondersteuning, dat groepsdebat (in vergelijking met stilzwijgend denken) de kans *verhoogt* dat een radicale innovatie wordt geselecteerd, echter alleen als de leden van een groep relatief goed zijn in het aanpassen van hun zelf-presentatie jegens de anderen. Als groepsleden relatief zwak zijn in het aanpassen van hun zelf-presentatie, dan *verlaagt* groepsdebat de kans dat de radicale innovatie wordt geselecteerd (ten faveure van de incrementele innovatie). Waarom is dit? Het is moeilijker om onder woorden te brengen waarom precies een bepaalde radicale innovatie een goed idee is, terwijl het relatief gemakkelijk is

om onder woorde ten brengen waarom een bepaalde incrementele innovatie te prefereren is. De marktvraag, klantbehoeften, productiekosten, etc. zijn namelijk beter bekend voor een incrementele innovatie dan voor een radicale innovatie. Individuen die initieel een voorkeur hebben voor de radicale innovatie zullen zich in de groep enkel goed staande kunnen houden als ze goed in staat zijn hun gedachten goed te presenteren. Anders zal hun mening minder zwaar tellen in de discussie dan de mening van diegenen die initieel de incrementele innovatie prefereren, en zullen ze het moeilijk vinden om stand te houden en zullen ze eerder in staat zijn hun mening aan te passen aan de groepsdiscussie die overheerst wordt door argumenten voor de incrementele innovatie. Derhalve verhoogt groepsdiscussie de kans dat de incrementele innovate wordt geadopteerd als groepsleden relatief zwak zijn in het aanpassen van hun zelf-presentatie in de groep. Andersom geredeneerd, verhoogt groepsdiscussie de kans dat de radicale innovatie wordt geadopteerd als groepsleden relatief goed zijn in het aanpassen van hun zelf-presentatie.

Samenvattend, concludeer ik uit deze drie studies dat, onder specifieke omstandigheden, stilzwijgend denken een positief effect kan hebben op creativiteit van het individu en van de groep, en eveneens een effect kan hebben op de soort innovatie geselecteerd door een groep.

Dit roept vele interessante vragen op voor verder onderzoek. Ten eerste, is het de vraag of het effect van de interactie van het vermogen tot het aanpassen van zelf-presentatie en de sensitiviteit voor uitdrukkingen van anderen op creativiteit (beschreven in hoofdstuk 2) ook geldt op het niveau van de groep, en of het afhangt van de grootte van de groep (aangezien de sensitiviteit voor uitdrukkingen van anderen mogelijk een grotere rol speelt als er meer personen zijn die zich uitdrukken).

Ten tweede, wat betreft hoofdstuk 3, zou het interessant zijn om te onderzoeken wat de effecten zijn van de lengte van en het startmoment (vroeg versus laat in de discussie) van het intermezzo voor stilzwijgend denken op de creativiteit van de groep. Het zou de externe validiteit versterken indien de studie herhaald kan worden met teams van managers in een onderneming.

Ten derde, kan men zich afvragen of het effect van extraversie op het effect van het intermezzo op team creativiteit lineair is? Dit vereist een groter aantal observaties dan in de studie in hoofdstuk 3.

Ten vierde, zouden de studies van hoofdstuk 3 en 4 gecombineerd kunnen worden in een studie om de vraag te beantwoorden wat het effect van een intermezzo voor stilzwijgend denken is op de selectie van radicale versus incrementele innovaties.

REFERENCES

Ahlum-Heath, M. E., & Di Vesta, F. J. 1986. The effect of conscious controlled verbalization of cognitive strategy on transfer in problem solving. ***Memory & Cognition,*** 14(3): 281-285.

Ahuja, G. 2000. Collaboration networks, structural holes, and innovation: a longitudinal study. ***Administrative Science Quarterly***, 45: 425-455.

Aiken, L., & West, S. 1991. ***Multiple regression: testing and interpreting interactions***. Newbury Park, CA: Sage.

Amabile, T. M. 1996. ***Creativity in Context***. Boulder, CO: Westview Press.

Ancona, D. G., & Caldwell, D. F. 1992. Demography and Design - Predictors of New Product Team Performance. ***Organization Science***, 3(3): 321-341.

Anderson, C., John, O. P., Keltner, D., & Kring, A. M. 2001. Who attains social status? Effects of personality and physical attractiveness in social groups. ***Journal of Personality and Social Psychology***, 81(1): 116-132.

Aronson, E., Wilson, T. D., & Brewer, M. B. 1998. Experimentation in social psychology. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), ***The handbook of social psychology***, 4th Ed. ed., Vol. 1. New York: Oxford University Press.

Atuahene-Gima, K. 2003. The effects of centrifugal and centripetal forces on product development speed and quality: How does problem solving matter? ***Academy of Management Journal***, 46(3): 359-373.

Atuahene-Gima, K., & Li, H. Y. 2004. Strategic decision comprehensiveness and new product development outcomes in new technology ventures. ***Academy of Management Journal***, 47(4): 583-597.

Atuahene-Gima, K., Slater, S. F., & Olson, E. M. 2005. The contingent value of responsive and proactive market orientations for new product program performance. ***Journal of Product Innovation Management***, 22(6): 464-482.

Baddeley, A. D. 1999. ***Essentials of Human Memory***. Hove, East Sussex: Psychology Press.

Bantel, K. A., & Jackson, S. E. 1989. Top management and innovations in banking: does the composition of the top team make a difference? ***Strategic Management Journal***, 10(Special issue: Strategic leaders and leadership (Summer, 1989)): 107-124.

Barkema, H. G., & Chvyrkov, O. 2007. Does top management diversity promote or hamper foreign expansion? ***Strategic Management Journal***, In Press.

Bartl, C. 2000. How verbalization revises cognition. ***International Journal of Psychology***, 35(3-4): 204-204.

Bartl, C., & Dorner, D. 1998. Speechless when thinking - about the role of speech for problem solving. ***Sprache & Kognition***, 17(4): 224-238.

Baum, J. R., & Wally, S. 2003. Strategic decision speed and firm performance. ***Strategic Management Journal***, 24(11): 1107-1129.

Berardicoletta, B., Dominowski, R. L., Buyer, L. S., & Rellinger, E. R. 1995. Metacognition and Problem-Solving - a Process-Oriented Approach. ***Journal of Experimental Psychology-Learning Memory and Cognition***, 21(1): 205-223.

Berry, D. C., & Broadbent, D. E. 1984. On the relationship between task performance and associated verbal knowledge. ***Quarterly Journal of Experimental Psychology Section a-Human Experimental Psychology***, 36a: 209-231.

Berteau, M. C. 1999. Spuren des Gespraechs in innerer Sprache. Versuch einer Analyse der dialogischen Anteile des lauten Denkens. ***Sprache & Kognition***, 18(1/2): 4-19.

Blau, P. 1977. ***Inequality and heterogeneity***. New York: Free Press.

Boeker, W. 1997. Strategic change: The influence of managerial characteristics and organizational growth. ***Academy of Management Journal***, 40(1): 152-170.

Bond, C. F., & Van Leeuwen, M. D. 1991. Can a part be greater than a whole? On the relationship between primary and meta-analytic evidence. ***Basic and Applied Social Psychology***, 12: 33-40.

Bourgeois, L. J., & Eisenhardt, K. M. 1988. Strategic Decision-Processes in High-Velocity Environments - 4 Cases in the Microcomputer Industry. ***Management Science***, 34(7): 816-835.

Briggs, S. R., Cheek, J. M., & Buss, A. H. 1980. An analysis of the self-monitoring scale. ***Journal of Personality and Social Psychology***, 38: 679-686.

Camacho, L. M., & Paulus, P. B. 1995. The Role of Social Anxiousness in Group Brainstorming. ***Journal of Personality and Social Psychology***, 68(6): 1071-1080.

Campbell, D. T. 1969. Blind variation and selective retention in creative thought as in other knowledge processes. ***Psychological Review***, 67(380-400).

Chi, M. T. H., Bassok, M., Lewis, M. W., Reimann, P., & Glaser, R. 1989. Self-explanations: how students study and use examples in learning to solve problems. ***Cognitive Science***, 13: 145-182.

Chi, M. T. H., de Leeuw, N., Chiu, M., & LaVancher, C. 1994. Eliciting self-explanations improves understanding. ***Cognitive Science***, 18: 439-477.

Chirumbolo, A., Livi, S., Manetti, L., Pierro, A., & Kruglanski, A. W. 2004. Effects of need for closure on creativity in small group interactions. ***European Journal of Personality***, 18: 265-278.

Christensen, C. M., & Bower, J. L. 1996. Customer power, strategic investment, and the failure of leading firms. ***Strategic Management Journal***, 17: 197-218.

Cohen, W. M., & Levinthal, D. A. 1990. Absorptive capacity: a new perspective on learning and innovation. ***Administrative Science Quarterly***, 35 (1): 128-152.

Connolly, T., Jessup, L. M., & Valacich, J. S. 1990. Effects of anonymity and evaluative tone on idea generation in computer-mediated groups. ***Management Science***, 36: 689-703.

Cook, T. D., & Campbell, D. T. 1979. ***Quasi-Experimentation; Design & Analysis Issues for Field Settings, chapter 2.*** Chicago, IL: Rand McNally College Publishing Company.

Costa, P. T., Jr., & McCrae, R. R. 1988. Personality in adulthood: a six-year longitudinal study of self-reports and spouse ratings on the NEO personality inventory. ***Journal of Personality and Social Psychology***, 54: 853-863.

Cottrell, N. B., Wack, D. L., Sekerak, G., J., & Rittle, R. H. 1968. Social facilitation of dominant responses by the presence of an audience and the mere presence of others. ***Journal of Personality and Social Psychology***, 9(3): 245-250.

Crossan, M. M., Lane, H. W., & White, R. E. 1999. An organizational learning framework: from intuition to institution. ***Academy of Management Review***, 24: 522-537.

Csikszentmihalyi, M. 1975. ***Beyond boredom and anxiety: the experience of play in work and games***. San Francisco: Jossey-Bass.

Davies, S. P. 2000. Move evaluation as a predictor and moderator of success in solutions to well-structured problems. ***Quarterly Journal of Experimental Psychology Section a-Human Experimental Psychology***, 53(4): 1186-1201.

De Dreu, C. K. W., & West, M. A. 2001. Minority dissent and team innovation: The importance of participation in decision making. ***Journal of Applied Psychology***, 86(6): 1191-1201.

De Saussure, F. 1915/1983. ***Course in general linguistics*** (R. Harris, Trans.). London: General Duckworth & Co.

Dean, J. W., & Sharfman, M. P. 1996. Does decision process matter? A study of strategic decisionmaking effectiveness. ***Academy of Management Journal***, 39(2): 368-396.

Dickson, J., McLennan, J., & Omodei, M. M. 2000. Effects of concurrent verbalization on a time-critical, dynamic decision-making task. ***Journal of General Psychology***, 127(2): 217-228.

Diehl, M., & Stroebe, W. 1987. Productivity loss in brainstorming groups: towards the solution of a riddle. ***Journal of Personality and Social Psychology***, 53(3): 497-509.

Diehl, M., & Stroebe, W. 1991. Productivity Loss in Idea-Generating Groups - Tracking Down the Blocking Effect. ***Journal of Personality and Social Psychology***, 61(3): 392-403.

Digman, J. M. 1989. Five robust trait dimensions: development, stability, and utility. ***Journal of Personality***, 57: 195-214.

Duncan, R. M., & Cheyne, A. 1999. Incidence and functions of self-reported private speech in young adults: A self-verbalization questionnaire. ***Canadian Journal of Behavioral Science***, 31: 133 - 136.

Eisenberger, R., & Armeli, S. 1997. Can salient reward increase creative performance without reducing intrinsic creative interest? ***Journal of Personality and Social Psychology***, 72: 652-663.

Eisenhardt, K. M. 1989. Making fast strategic decisions in high-velocity environments. ***Academy of Management Journal***, 32: 543-576.

Eisenhardt, K. M., & Zbaracki, M. J. 1992. Strategic Decision-Making. ***Strategic Management Journal***, 13: 17-37.

Ericsson, K. A., & Simon, H. A. 1993. ***Protocol analysis: verbal reports as data***. Cambridge, MA: MIT Press.

Faems, D., Van Looy, B., & Debackere, K. 2005. Interorganizational collaboration and innovation: Toward a portfolio approach. ***Journal Of Product Innovation Management***, 22(3): 238-250.

Fiore, S. M., & Schooler, J. W. 2002. How did you get here from there? Verbal overshadowing of spatial mental models. ***Applied Cognitive Psychology***, 16(8): 897-910.

Fleck, J. I., & Weisberg, R. W. 2004. The use of verbal protocols as data: An analysir of insight into the candle problem. ***Memory and Cognition***, 32: 990-1006.

Forbes, D. P. 2005. Managerial determinants of decision speed in new ventures. ***Strategic Management Journal***, 26: 355-266.

Fredrickson, J. W. 1984. The comprehensiveness of strategic decision processes: extension, observations, future directions. ***Academy of Management Journal***, 27: 445-466.

Gabrenya, W. K. J., & Arkin, R. M. 1980. Self-monitoring scale: factor structure and correlates. ***Personality and Social Psychology Bulletin***, 6: 13-22.

Gagne, R. H., & Smith, E. C. 1962. A study of the effects of verbalization on problem solving. ***Journal of Experimental Psychology***, 63: 12-18.

Gazzaniga, M. S., Ivry, R. B., & Mangun, G. R. 2002. ***Cognitive neuroscience: the biology of the mind*** (2nd ed.). New York: W.W. Norton & Company.

Gilovich, T., Medvec, V., & Savitsky, K. 2000. The spotlight effect in social judgment: an egocentric bias in estimates of the salience of one's own actions and appearance. ***Journal of Personality and Social Psychology***, 78: 211-222.

Goldberg, L. R. 1990. An alternative "description of personality": the big-five factor structure. ***Journal of Personality and Social Psychology***, 59: 1216-1229.

Goncalo, J. A., & Staw, B. M. 2006. Individualism-collectivism and group creativity. ***Organizational Behavior and Human Decision Processes***, 100: 96-109.

Guilford, J. P. 1967. ***The nature of human intelligence***. New York: McGraw-Hill.

Hacker, W., & Wetzstein, A. 2004. Verbalised reflection and solution quality in design problem solving. ***Zeitschrift Fur Psychologie***, 212(3): 152-166.

Harcourt. 2006. ***Dutch NEO-FFI Test, used with approval.***

Henderson, R. M., & Clark, K. B. 1990. Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms. ***Administrative Science Quarterly***, 35(1): 9-30.

Hill, C. W. L., & Rothaermel, F. T. 2003. The performance of incumbent firms in the face of radical technological innovation. ***Academy of Management Review***, 28(2): 257-274.

Hiller, N. J., & Hambrick, D. C. 2005. Conceptualizing executive hubris: the role of (hyper-)core self-evaluations in strategic decision-making. ***Strategic Management Journal***, 26: 297-319.

Hinsz, V. B., Tindale, R. S., & Vollrath, D. A. 1997. The emerging conceptualization of groups as information processors. ***Psychological Bulletin***, 121(1): 43-64.

Hocevar, D., & Bachelor, P. 1989. A taxonomy and critique of measurements used in the study of creativity. In R. R. R. a. C. R. R. J.A. Glover (Ed.), ***Handbook of Creativity***: 53-76.

Hofmann, D. A., & Jones, L. M. 2005. Leadership, collective personality, and performance. ***Journal of Applied Psychology***, 90(3): 509-522.

Holodynski, M. 2004. The miniaturization of expression in the development of emotion self-regulation. ***Development Psychology***, 40: 16-28.

Hough, J. R., & White, M. A. 2003. Environmental dynamism and strategic decision-making rationality: An examination at the decision-level. ***Strategic Management Journal***, 24(5): 481-489.

Hussy, W. 1987. Zur Steuerfunktion der Sprache beim Problemloesen. ***Sprache & Kognition***, 6(14-22).

Isenberg, D. J. 1986. Group polarization: a critical review and meta-analysis. ***Journal of Personality and Social Psychology***, 50: 1141-1151.

James, L. M., & Olson, J. M. 2000. Jeer pressure: the behavioral effects of observing ridicule of others. ***Personality and Social Psychology Bulletin***, 26: 474-485.

Jehn, K. A., & Mannix, E. A. 2001. The dynamic nature of conflict: A longitudinal study of intragroup conflict and group performance. ***Academy of Management Journal***, 44(2): 238-251.

Judge, W., & Miller, A. 1991. Antecedents and outcomes of decision speed in different environmental contexts. ***Academy of Management Journal***, 34(449-463).

Jung, C. G. 1923. ***Psychological types*** (1971 ed.). London: Routledge & Kegan Paul.

Keller, R. T. 2001. Cross-functional project groups in research and new product development: Diversity, communications, job stress, and outcomes. ***Academy of Management Journal***, 44(3): 547-555.

Kelly, K. M., Jones, W. H., & Adams, J. M. 2002. Using the imaginary audience scale as a measure of social anxiety in young adults. ***Educational and Psychological Measurement***, 62(5): 869-914.

Kim, H. S. 2002. We talk, therefore we think? A cultural analysis of the effect of talking on thinking. ***Journal of Personality and Social Psychology***, 83 (4): 828-842.

Korsgaard, M. A., Schweiger, D. M., & Sapienza, H. J. 1995. Building Commitment, Attachment, and Trust in Strategic Decision-Making Teams - the Role of Procedural Justice. ***Academy of Management Journal***, 38(1): 60-84.

Larkin, J. E. 1987. Are good teachers perceived as high self-monitors? *Personality and Social Psychology Bulletin*, 13: 64-72.

Laughlin, P. R., Hatch, E. C., Silver, J. S., & Boh, L. 2006. Groups perform better than the best individuals on letters-to-numbers problems: Effects of group size. *Journal of Personality and Social Psychology*, 90(4): 644-651.

Laughlin, P. R., Vanderstoep, S. W., & Hollingshead, A. B. 1991. Collective Versus Individual Induction - Recognition of Truth, Rejection of Error, and Collective Information-Processing. *Journal of Personality and Social Psychology*, 61(1): 50-67.

Laughlin, P. R., Zander, M. L., Knievel, E. M., & Tan, T. K. 2003. Groups perform better than the best individuals on letters-to-numbers problems: Informative equations and effective strategies. *Journal of Personality and Social Psychology*, 85(4): 684-694.

Leary, M. R., & Kowalski, R. M. 1993. The interaction anxiousness scale: construct and criterion-related validity. *Journal of Personality Assessment*, 61(1): 136-146.

Lennox, R. D., & Wolfe, R. N. 1984. Revision of the self-monitoring scale. *Journal of Personality and Social Psychology*, 46: 1349-1364.

Levelt, W. J. M. 1989. *Speaking: from intention to articulation*. Cambridge, MA: MIT Press.

Lieberman, M. D., & Rosenthal, R. 2001. Why introverts can't always tell who likes them: Multitasking and nonverbal decoding. *Journal of Personality and Social Psychology*, 80(2): 294-310.

Luria, A. R. 1982. ***Language and Cognition***. John Wiley & Sons, Inc.

March, J. 1991. Exploration and exploitation in organizational learning. ***Organization Science***, 2 (1): 71-87.

McCrae, R. R., & Costa, P. T., Jr. 1997. Personality trait structure as a human universal. ***American Psychologist***, 52: 509-516.

McCrae, R. R., & John, O. P. 1992. An introduction to the five-factor model and its applications. ***Journal of Personality***, 2: 175-215.

McGrath, J. E. 1984. ***Groups: interaction and performance***. Englewood Cliffs, NJ: Prentice-Hall.

McGrath, R. G. 2001. Exploratory learning, innovative capacity, and managerial oversight. ***Academy of Management Journal***, 44 (1): 118-131.

Miller, M. L., & Thayer, J. F. 1989. On the existence of discrete classes in personality: is self-monitoring the correct joint to carve? ***Journal of Personality and Social Psychology***, 57: 143-155.

Mintzberg, H., Raisinghani, D., & Theoret, A. 1976. The structure of 'unstructured decision processes'. ***Administrative Science Quarterly***, 21: 246-275.

Mullen, B., Johnson, C., & Salas, E. 1991. Productivity loss in brainstorming groups: a meta-analytic integration. ***Basic and Applied Social Psychology***, 12: 3-23.

Narver, J. C., Slater, S. F., & MacLachlan, D. L. 2004. Responsive and proactive market orientation and new-product success. ***Journal of Product Innovation Management***, 21(5): 334-347.

Nemeth, C. J., Personnaz, B., Personnaz, M., & Goncalo, L. 2004. The liberating role of conflict in group creativity: A test in two countries. ***European Journal of Social Psychology***, 34: 365-374.

Nijstad, B. A. 2000. ***How the group affects the mind: effects of communication in idea generating groups.*** Utrecht, Netherlands: Interuniversity Center for Social Science Theory and Methodology.

Nijstad, B. A., & Paulus, P. B. 2003a. Group creativity: Common themes and future directions. In P. B. Paulus, & B. A. Nijstad (Eds.), ***Group Creativity***. New York: Oxford University Press.

Nijstad, B. A., Stroebe, W., & Lodewijkx, H. F. M. 2003b. Production blocking and idea generation: Does blocking interfere with cognitive processes? ***Journal of Experimental Social Psychology***, 39(6): 531-548.

Nijstad, B. A., van Vianen, A. E. M., Stroebe, W., & Lodewijkx, H. F. M. 2004. Persistence in brainstorming: Exploring stop rules in same-sex groups. ***Group Processes & Intergroup Relations***, 7(3): 195-206.

Nonaka, I., & Takeuchi, H. 1995. ***The knowledge-creating company***. New York: Oxford University Press.

Nutt, P. C. 1984. Types of organizational decision processes. ***Administrative Science Quarterly***, 29(3): 414-450.

Nutt, P. C. 2002. Breaking out of the failure mode with best practice decision making processes. ***Working document***.

O'Grady, W., Archibald, J., Aronoff, M., & Rees-Miller, J. 2001. ***Contemporary Linguistics***. Boston, MA: Bedford/St. Martins.

Okhuysen, G. A. 2001. Structuring change: Familiarity and formal interventions in problem-solving groups. ***Academy of Management Journal***, 44(4): 794-808.

Osborn, A. F. 1953. ***Applied imagination: principles and procedures of creative problem-solving***. New York: Charles Scribner's Sons.

Oxley, J. E., & Sampson, R. C. 2004. The scope and governance of international R&D alliances. ***Strategic Management Journal***, 25(8-9): 723-749.

Papadakis, V., & Barwise, P. 1998. ***Strategic decisions***. Norwell, MA: Kluwer.

Papadakis, V. M., Lioukas, S., & Chambers, D. 1998. Strategic decision-making processes: The role of management and context. ***Strategic Management Journal***, 19(2): 115-147.

Paulus, P. B., & Dzindolet, M. T. 1993. Social-Influence Processes in Group Brainstorming. ***Journal of Personality and Social Psychology***, 64(4): 575-586.

Paulus, P. B., Larey, T. S., & Ortega, A. H. 1995. Performance and perceptions of brainstormers in an organizational setting. ***Basic and Applied Social Psychology***, 17: 249-265.

Penner-Hahn, J., & Shaver, J. M. 2005. Does international research and development increase patent output? An analysis of Japanese pharmaceutical firms. ***Strategic Management Journal***, 26(2): 121-140.

Plant, R. W., & Ryan, R. M. 1985. Intrinsic motivation and the effects of self-consciousness, self-awareness, and ego-involvement: an investigation of internally controlling styles. ***Journal of Personality***, 53: 435-449.

Porter, C. O. L. H., Hollenbeck, J. R., Ilgen, D. R., Ellis, A. P. J., West, B. J., & Moon, H. 2003. Backing up behaviors in teams: The role of personality and legitimacy of need. ***Journal of Applied Psychology***, 88(3): 391-403.

Postmes, T., Spears, R., & Cihangir, S. 2001. Quality of decision making and group norms. ***Journal of Personality and Social Psychology***, 80: 918-930.

Rajagopalan, N., Rasheed, A., Datta, D. K., & Spreitzer, G. M. 1998. A multi-theoretic model of strategic decision making processes. In V. Papadakis, & P. Barwise (Eds.), ***Strategic decisions***: 229-249. Norwell, MA: Kluwer Academic.

Reagans, R., & Zuckerman, E. W. 2001. Networks, diversity, and productivity: The social capital of corporate R&D teams. ***Organization Science***, 12(4): 502-517.

Rietzschel, E. F., De Dreu, C. K. W., & Nijstad, B. A. 2006. Personal need for structure and creative performance: the moderating influence of fear of invalidity. ***Unpublished manuscript***.

Rietzschel, E. F., Nijstad, B. A., & Stroebe, W. 2006. Relative accessibility of domain knowledge and creativity: The effects of knowledge activation on the quantity and quality of generated ideas. ***Unpublished manuscript***.

Roberto, M. A. 2004. Strategic decision-making processes: Beyond the efficiency-consensus trade-off. ***Group & Organization Management***, 29(6): 625-658.

Rothaermel, F. T., & Deeds, D. L. 2004. Exploration and exploitation alliances in biotechnology: A system of new product development. ***Strategic Management Journal***, 25(3): 201-221.

Schooler, J. W. 2002. Verbalization produces a transfer inappropriate processing shift. ***Applied Cognitive Psychology***, 16(8): 989-997.

Schooler, J. W., & Engstler-Schooler, T. Y. 1990. Verbal overshadowing of visual memories: some things are better left unsaid. ***Cognitive Psychology***, 22: 36-71.

Schooler, J. W., Ohlsson, S., & Brooks, K. 1993. Thoughts beyond words: when language overshadows insight. ***Journal of Experimental Psychology: General***, 122 (2): 166-183.

Shuptrine, F. K., Bearden, W. O., & Teel, J. E. 1990. An analysis of the dimensionality and reliability of the Lennox and Wolfe revised self-monitoring scale. ***Journal of Personality Assessment***, 54: 515-522.

Silvia, P. J., & Phillips, A. G. 2004. Self-awareness, self-evaluation, and creativity. ***Personality and Social Psychology Bulletin***, 30(8): 1009-1017.

Simons, T., Pelled, L. H., & Smith, K. A. 1999. Making use of difference: Diversity, debate, and decision comprehensiveness in top management teams. ***Academy of Management Journal***, 42(6): 662-673.

Simonton, D. K. 1998. Donald Campbell's Theory of Creativity - Donald Campbell's Model of the Creative Process: Creativity as Blind Variation and Selective Retention. ***The journal of creative behavior***, 32(3): 153-158.

Simonton, D. K. 1999. Creativity as blind variation and selective retention: is the creative process Darwinian? ***Psychological Inquiry***, 10: 309-328.

Simonton, D. K. 2000. Creativity: cognitive, personal, developmental and societal aspects. ***American Psychologist***, 55 (1): 151-158.

Slobin, D. I. 2000. How language can direct thought: Linguistic Relativity and Linguistic Determinism. In R. L. Atkinson, R. C. Atkinson, E. E. Smith, D. J. Bem, & S. Nolen-Hoeksema (Eds.), ***Hilgard's Introduction to Psychology***: 342.

Snyder, M. 1974. Self-monitoring of expressive behavior. ***Journal of Personality and Social Psychology***, 30: 526-537.

Snyder, M., & Gangestad, S. 1986. On the nature of self-monitoring: matters of assessment, matters of validity. ***Journal of Personality and Social Psychology***, 51: 125-139.

Stasser, G. 1992. Pooling of unshared information during group discussions. In S. Worchel, W. Wood, & J. A. Simpson (Eds.), ***Group process and productivity***: 48-67. Newbury Park, CA: Sage.

Stasser, G., Vaughan, S. I., & Stewart, D. D. 2000. Pooling unshared information: The benefits of knowing how access to information is distributed among group members. ***Organizational Behavior and Human Decision Processes***, 82(1): 102-116.

Steinberg, D. D., Nagata, H., & Aline, D. P. 2001. ***Psycholinguistics: Language, Mind and World, 2nd edition***. Harlow, UK: Longman Linguistics Library, Pearson Education.

Steinel, W. 2004. ***Misleading in social decision-making: a motivational approach***: Unpublished doctoral dissertation, University of Amsterdam, Netherlands.

Stinessen, L. 1985. The influence of verbalization on problem-solving. ***Scandinavian Journal of Psychology***, 26: 342-347.

Stroebe, W., & Diehl, M. 1994. Why groups are less effective than their members: on productivity losses in idea-generating groups. In W. Stroebe, & M. Hewstone (Eds.), ***European Review of Social Psychology***, Vol. 5: 271-303. London: John Wiley & Sons.

Stroebe, W., Diehl, M., & Abakoumkin, G. 1992. The Illusion of Group Effectivity. ***Personality and Social Psychology Bulletin***, 18(5): 643-650.

Strunk, W.J., & White, E.B. 2000. ***The elements of style (4th ed.)*** Needham Heights, MA: Allyn & Bacon.

Szymanski, K., & Harkins, S. G. 1992. Self-evaluation and creativity. ***Personality and Social Psychology Bulletin***, 18(259-265).

Torrance, E. P. 1962. ***Guiding creative talent***. Englewood Cliffs, New Jersey: Prentice Hall.

Vygotsky, L. S. 1934/1986. ***Thought and language*** (A. Kozulin, Trans.). Cambridge, MA: The MIT Press.

Wally, S., & Baum, J. R. 1994. Personal and Structural Determinants of the Pace of Strategic Decision-Making. ***Academy of Management Journal***, 37(4): 932-956.

West, M. A., & Farr, J. L. 1990. Innovation at work. In M. A. W. a. J. L. Farr (Ed.), ***Innovation and creativity at work: Psychological and organizational strategies***: 3-13.

Wetzstein, A., & Hacker, W. 2004. Reflective verbalization improves solutions - The effects of question-based reflection in design problem solving. ***Applied Cognitive Psychology***, 18(2): 145-156.

Wiersema, M. F., & Bantel, K. A. 1992. Top management team demography and corporate strategic change. ***Academy of Management Journal***, 35(1): 91-121.

Wilson, T. D., Lisle, D. J., Schooler, J. W., Hodges, S. D., Klaaren, K. J., & Lafleur, S. J. 1993. Introspecting About Reasons Can Reduce Post-Choice Satisfaction. ***Personality and Social Psychology Bulletin***, 19(3): 331-339.

Wilson, T. D., & Schooler, J. W. 1991. Thinking Too Much - Introspection Can Reduce the Quality of Preferences and Decisions. ***Journal of Personality and Social Psychology***, 60(2): 181-192.